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Electrically Heated Glass Annealing Lehrs

By E. F. COLLINS*

(*Written for* THE GLASS INDUSTRY)

The accurate degree of temperature control through a cycle of temperatures which is necessary in annealing glass, and the difficulty of securing it in the ordinary fuel fired lehr, have led to experiments with a view to developing electrically heated lehrs. One such lehr which has been running several months on a high grade of glass ware, and on which reliable over-all factory costs have been kept, shows a decrease in cost per unit annealed of 20%. This saving is about 75 times the total cost of power for heating the lehr.

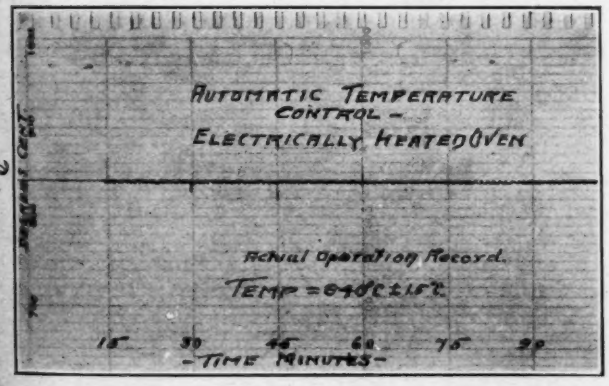
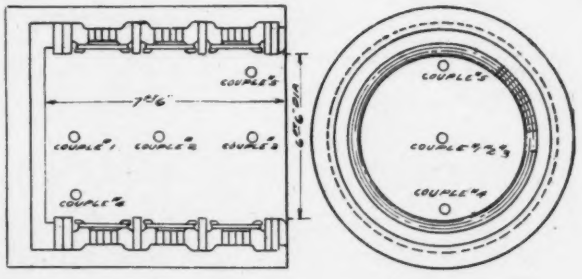


FIG. 1. TIME TEMPERATURE CURVE OF ACTUAL FERFORMANCE ON AN ELECTRIC LEHR.

Generally speaking, the annealing temperature for glass is that constant and uniform temperature at which any stresses which exist in the ware are permitted to relax. The length of the anneal, of "annealing time" depends on the magnitude of the stresses existing before annealing occurs, being a function of each point within the necessary temperature range.

In all glass annealing it is of vital importance that the temperature of the glass mass should be very uniform in the annealing range. Temperature gradients in the mass of homogeneous glass under treatment are solely responsible for setting up strains. These gradients may result either from too rapid cooling, or from a non-uniform and uneven heat distribution. Hence the importance of heat control with respect to time and also proper heat distribution in the lehr through which the ware is passing. Where glass is treated in the box type oven it is also extremely important that the distribution be good, and that the heating equipment lends itself to the exact following of the time temperature cycle desired, whether it covers a few hours, or a month. Preferably this control should be automatic and correspond to a predetermined cycle; it is for this reason that electrically heated lehrs are successful.



TIME	THERMOCOUPLES 1	2	3	4	5	AVG. TEMP	DEVIATION FROM AVERAGE ABOVE	BELOW	RATE OF CHANGE DEG. PER. HR.	
11 10	25	25	25	25	25	25	0	0		
3 20	527	537	532	530	545	534	2.07	1.31	127°C	
7 20	670	679	671	666	669	669	1.5	.45	34	
11 20	777	783	776	766	780	776	1.0	1.3	27	
3 30	858	864	857	849	864	860	.46	1.3	21	
7 30	860	865	862	862	863	862	.35	.23	0	
11 30	928	934	930	930	928	930	.43	.21	17	
3 30	933	932	927	925	927	929	.64	43	0	
4 30	950	950	952	952	955	952	31	21	23	

FIG. 2. AN EXAMPLE OF TEMPERATURE DISTRIBUTION IN AN ELECTRIC FURNACE.

Such automatic control with limits of plus or minus 2.5° C. is available if electrically heated lehrs of proper design are used. Fig. 1 is a time temperature curve of actual performance on an electric lehr, and the temperature is shown to be held constant within one-third of one per cent.

*General Electric Company, Schenectady, N. Y.

An example of temperature distribution in an electric furnace is given in Fig. 2, with its accompanying table. It will be noted that on this record of temperature distribution that, for a rising temperature of 125° per hour, over the first four hours, only one point varies from the mean temperature by 2.07%. Over the next four hours, with 35° change per hour, the maximum variation from mean temperature is 1.5%, the maximum at the rate of 17° per hour is .43%, while at constant temperatures, at 860° variation is .35 of one per cent, and at 930°, .64 of one per cent. These figures are for an oven 6′ 6″ in diameter, and 7′ 6″ deep. Such accuracy of control and evenness of heat distribution as these figures show, would seem to meet the most exacting requirements of any and all types of glass annealing, including that of large lenses for telescopic work.

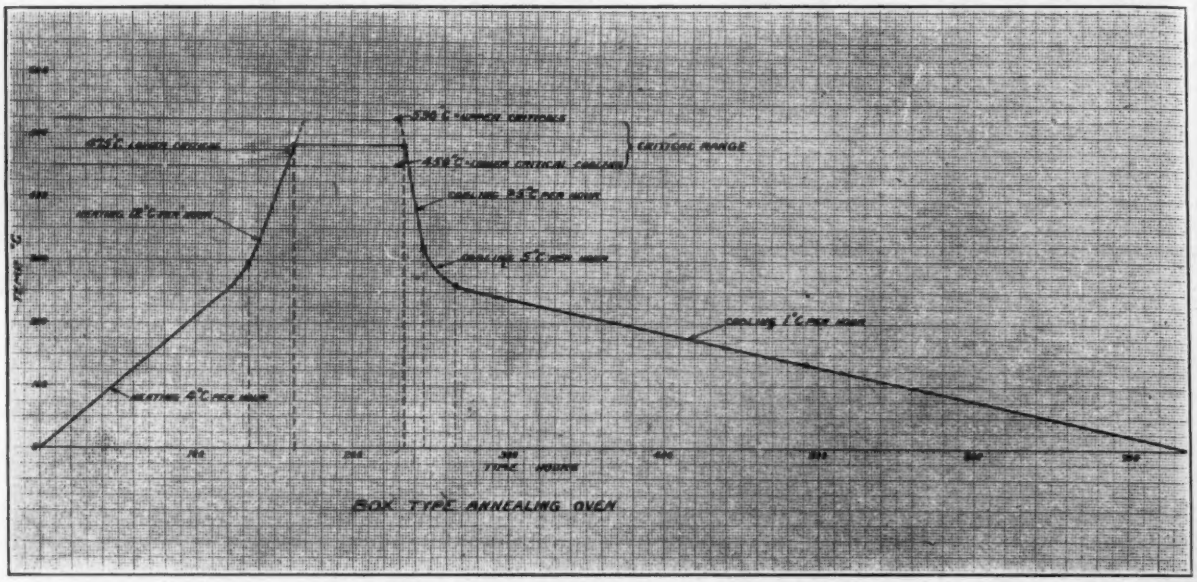
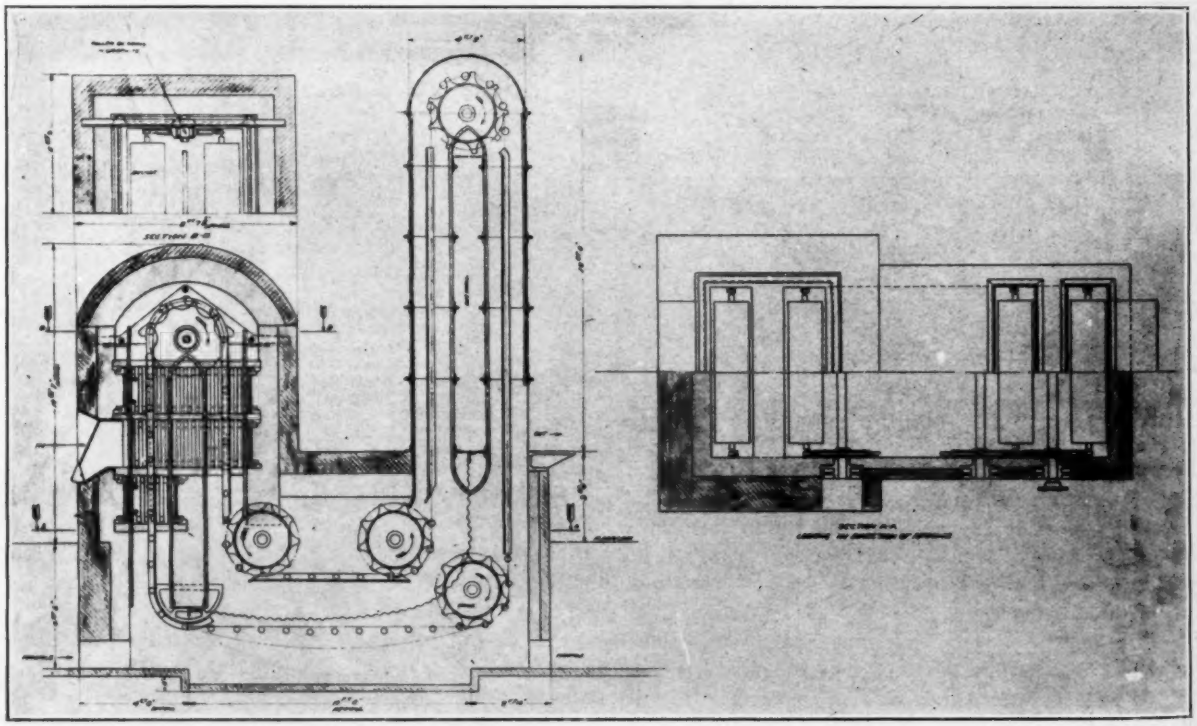


FIG. 3. GRAPHIC REPRESENTATION OF TIME TEMPERATURE CYCLE FOR ANNEALING FINE CROWN GLASS FOR TELESCOPE LENSES.



SECTIONAL VIEWS OF TYPE OF ELECTRICALLY HEATED LEHR, WHICH HAS BEEN IN SUCCESSFUL OPERATION FOR SEVERAL MONTHS.

Fig. 3 is a graphic representation of the time temperature

cycle for annealing fine crown glass for a telescope lens. Such process is best carried on in the box type of lehr in which the lens is placed, and subjected to a temperature cycle as shown. With electric heat, automatic control is available by means of which this particular cycle or any similar one may be accurately followed, and repeated exactly whenever desired. The control instrument is operated by a time keeping motor supplemented by a simple cam arranged to give different rates of heating or cooling, according to the predetermined characteristic as shown on the curve. Certain tests for fine anneal with this type of apparatus have been

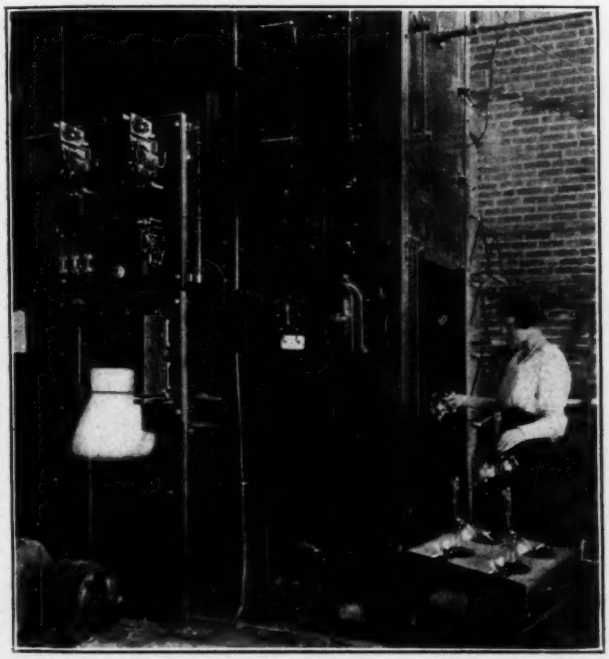


FIG. 5. MODIFIED TYPE, ELECTRICALLY HEATED GLASS LEHR.

made, and reports seem to indicate that results may be obtained that have not been realized with any former method of annealing. These results are not a matter of chance, but may be duplicated repeatedly due to the well-nigh perfect heat distribution, coupled with an absolutely accurate and dependable control of the temperature time cycle.

Fig. 5 is a modified type of electrically heated glass lehr which has been installed and working in one of the plants of the General Electric Company for several months. It has been annealing X-ray tubes, which are a class of ware requiring the best anneal. It is of the vertical type, automatically controlled. The results given by this lehr, both in the excellence of anneal, and in the decreased number of broken or rejected tubes have been such as to thoroughly demonstrate its practicality for commercial annealing.

Exact operating costs for electrically heated lehrs are not yet available but, from estimates made for such work, it is believed that costs will be greatly in favor of the electrically heated lehr, especially when the improved quality of the product, increased production, and elimination of rejects are taken into account. The estimate for the vertical type mentioned above is 10 lbs. of glass per KW-hr., figures based on ware entering at 900° F. and being raised to a temperature not exceeding 1200° F. A horizontal lehr, which would give the same results would occupy a floor space of 70 x 10 ft., being 10 ft. high and its glass capacity would be 600 lbs. per hour. The vertical type would occupy a floor space of 21 x 18 ft. and its glass capacity would be 500 lbs. per hour. The connected loads would be 125 KW. for the horizontal type and 60 KW. for the vertical.

In summing up, the principal advantages of the electrically heated lehr, which contribute to its better operating economy are, high thermal efficiency, facility of securing heat distribution, heat control, whereby plus or minus 2.5° C. may be secured automatically and the fact that the annealing time is less than half that required by the fuel fired lehr. The factors that assist in turning out better products are, first, there is no opportunity for the ware to absorb the products of combustion, hence no sulphuring takes place, and the product has a bright, polished surface requiring no washing or cleansing. Second, the ware is sterile, and absolutely clean, due to the heat, which is important for prescription ware, allowing medicinals to be sealed in as soon as the ware leaves the oven. Lastly, there is the low temperature gradient, which eliminates breakage, distortion and products developing flaws under the tests given after annealing.

[EDITORIAL NOTE.—Electrically heated annealing lehrs, similar in principle to that described above, are said to be in successful commercial operation at the Spencer Lens Company's plant, Hamburg, New York, and at the Illinois Glass Company, Alton, Illinois. At the latter factory, an electric lehr approximately 20 by 60 feet in size is reported to be used for annealing large articles such as glass carboys.]

A Substitute for Diamonds*

The diamond plays an important part in the industry on account of its extraordinary hardness. It is used principally for drilling and glass cutting. Recently a substitute has been found through research on the subject of carbides. Especially silicon, molybdenum-carbide and tungsten carbide gave promising results. At first it was attempted to press these materials into the desired shape by using binding material which, however, impaired the mechanical strength and hardness. The binding material often was volatilized at the high temperatures. Many difficulties interfered until tungsten carbide was made, having a hardness of 9.8 on Mohr's scale, which closely approaches the hardness of diamond, which is 10. The required temperature of 3,000° C had been obtained earlier but no uniform material could be made because of the difference in temperature between the source of heat and the bottom of the crucible. For uniformity of the carbide, an equal temperature throughout the oven is necessary. Through a special method of construction it has become possible to manufacture several pounds in one operation of a material which has the necessary chemical and physical uniformity. The next step was to make objects from the loose crystals. This also has become possible through a casting process. The diamond substitute has been put on the market under the name of "Volomit." It has already found many applications in the industry.

*Diamant, Vol. 43, No. 10, p. 180.

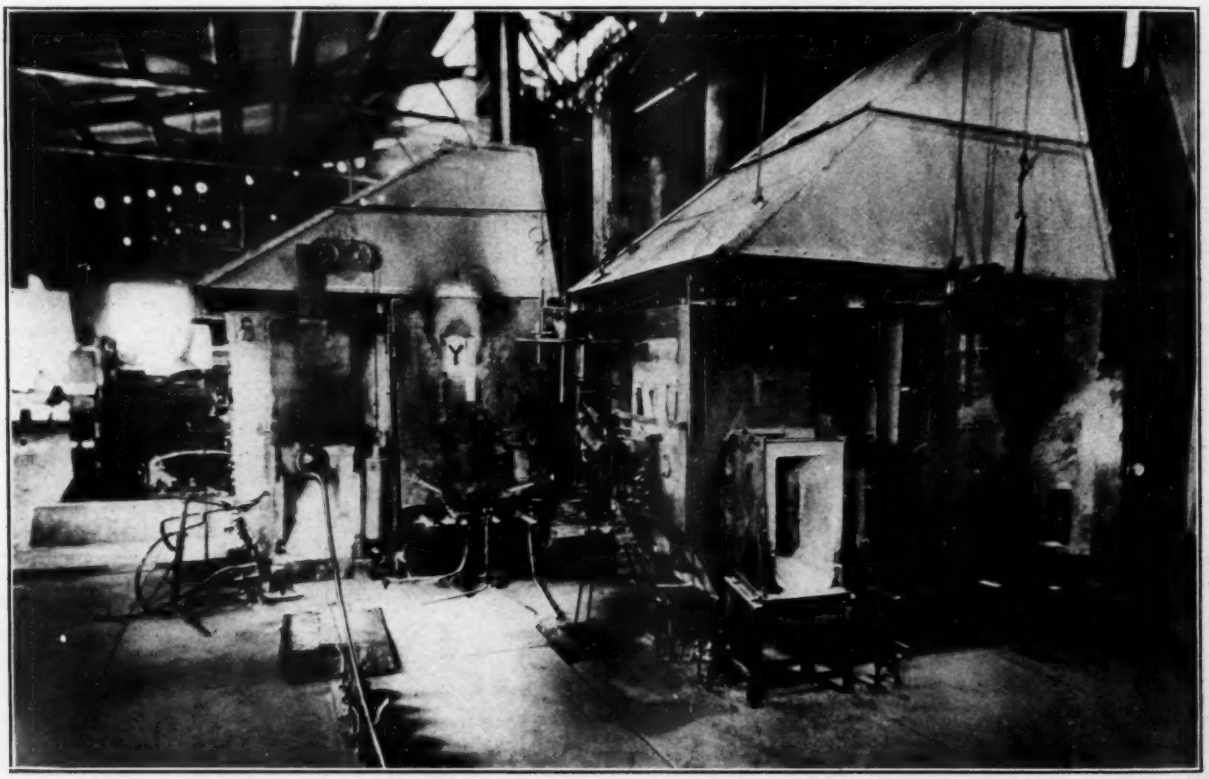
Machine Drawing of Glass Tubing

By J. F. SPRINGER

(*Written for* THE GLASS INDUSTRY)

The industrial position of the United States is, today, largely based on mechanical methods of handling work. There is probably no other country in the world where, viewed as a whole, the workmen not only receive more money than elsewhere, but are able to buy more for the money received. By this I do not mean that prices for commodities bought by the workman are lower. They may be higher, in many cases. What I do mean is that, notwithstanding the prices he has to pay, the workman receives enough in wages to buy more freely. Some businesses are based largely on mechanical methods. Farming is one of these. And there are multitudes of others. The manufacture of hollow glass articles has resisted the invasion of machines for a long time, but they have been introduced more and more. The Kimble Glass Company, at Vineland, N. J., engaged in the manufacture of such hollow articles as tubing, medicinal vials and the like, is an example of the free application of machines. Here there are machines doing all sorts of things.

There is a quadruple installation of tube drawing machines for example. With this equipment in full operation, four tubes of independent dimensions may be simultaneously drawn. The machines operate continuously. This contrasts with the hand-drawing method, where only a small batch of glass weighing but a few pounds is drawn at a time. The operation may be repeated indefinitely; but every repetition calls for the withdrawal of a new supply of glass from the furnace and the preparation of this gob for the drawing operation. By the machine method the glass flows continuously from the furnace. The tube is forever being drawn. As it is drawn and as it becomes cool at a point distant from the furnace, it is continuously cut off to moderate lengths. This cutting off is an automatic process carried out by a special mechanical device. There is, as in the hand process, a long line of tubing between the blow-pipe and the far end. But, in the machine process, this long line is continually moving in one direction—away from the furnace. However, in spite of such differences, the principle underlying both methods is the same. The glass is drawn off of the end of a blow-pipe by a simple forward movement.



REHEATING END OF FURNACE SHOWING TROUGHS AND ARBOR. THE HOOK SHOWN HUNG ON CORNER OF FURNACE IN FOREGROUND IS USED TO GAUGE MOLTEN GLASS IN TROUGH THROUGH OPENING Y

At the Kimble works, the tubing manufactured, whether by the hand or the machine process, is largely used up on the spot. That is, a large percentage is employed as the stock from which vials and similar articles are made. In this manufacture, machines are used to a large extent. Two of the most interesting of these are employed in making vials of the general description of those used by homeopathic physicians as containers of small round pills. Such a vial will, in a representative case, have a cylindrical body with a

bottom perpendicular to the axis. The neck will be cylindrical and will stand on rather "square" shoulders. The one machine works up blanks consisting each of a short length of tubing long enough to furnish the stock for two vials. The two necks are put on at the two ends of the tube. First, the blanks are run through the machine and all receive a neck at one end. Then the articles are run through again on the same or a similar machine and necks put on at the other end of all of them. These are, substantially, identical operations. When they are completed, the output consists of pieces of tubing each with two necks and a clear air space all the way through.

The length of the double-necked blank is now something in excess of the combined lengths of two finished vials placed bottom to bottom. The excess is to supply material for the two bottoms required for the vials that are to be made by the second machine from the two-necked tubes. The machine operates on the amidships region of each tube, turning the whole and heating this central zone. At just the right moment, the tube is pulled apart at the center and the glass closes up on each half.

The machine squares the bottoms simultaneously while the vials are still held in line with each other. And the job is done. Two vials have been made. The whole operation occupies but a very short time. The machines are completely automatic. They require general attention, as automatic machines usually do. They feed themselves the individual blanks, so about all the feeding required of the attendant is to put in place a new batch of blanks.

These are examples of what is going on at the Kimble works. The aim of the concern seems to be to do nothing by hand that may be done mechanically.

TUBE DRAWING MACHINE

The tube drawing machine is the invention of Edward Danner. It is covered by patents, issued in March, 1917, and assigned to the Libbey Glass Company. The following description of the machine is based principally on the patent descriptions, and may be regarded as fairly representative of the actual machines installed in Vineland and at Toledo and Sandusky, Ohio, Bridgeville, Pennsylvania and elsewhere. A modified type, arranged to draw the tubing vertically in a tower, is used at the Corning Glass Works, Corning, New York. The apparatus presupposes a continuous supply of molten glass. This may be furnished by a tank furnace of suitable capacity, or by any equivalent means. Naturally a pot furnace does not lend itself very well to this use. However, the machine itself is indifferent to the mode of providing a supply. All it requires is that a steady stream of molten glass be available, the only checking of which will be for the convenience of the tube drawing machine itself.

There is a special furnace which forms a part of the tube drawing equipment. In the upper part of the fire chamber of this furnace, a trough is arranged. At one end this trough receives molten glass from the source of supply. There is a doorway through which this supply may come and a suitable means of opening and closing. The trough is of stepped construction, forcing the glass to drop to other levels as it flows on. This dropping is considered as facilitating the elimination of air bubbles. The furnace heat from below is for the purpose of keeping the glass hot and perhaps giving it just the temperature desired at this point. There is, near the discharge end of the trough, a second door which serves as a means of controlling the amount of glass delivered by the trough and upon occasion of cutting off the delivery altogether. The glass by this time has flowed perhaps two-thirds of the way across the furnace. The glass now flows into a portion of the furnace where it receives heat from a second special source. This heat may come from burners supplied by oil or gas or some equivalent equipment. The door or gate, already mentioned as the means of controlling the amount of glass discharged by the trough, may be a vertical diaphragm controlled from the furnace roof by a hand wheel operating a threaded rod secured to the top of the diaphragm.

A big blow-pipe is arranged transversely of the main body of the trough and is set so as to be inclined to the horizontal. This blow-pipe is located below the trough. In fact, it is set to receive the glass as it flows from the trough in a slow

CONTINUOUS TUBE OF GLASS BEING DRAWN FROM DISCHARGE END OF BLOW PIPE.

stream. The blow-pipe is mounted so as to be capable of rotation. The higher end is supported in the rear wall and the lower or free end registers with an opening provided in the front wall. If the reader will recall certain points already mentioned, he will now understand that for an observer facing the furnace and having the blow-pipe pointed downwards at him, the stream of glass flowing through the trough will flow across the line of sight.

The business end of the blow-pipe that is inside the furnace is covered with some kind of fire resisting material, as fire-clay. This sheath is made quite thick near the rear wall of the furnace and tapers gently to a less thickness at the terminal point of the blow-pipe. The trough is narrowed in the discharge region and this part is also directed so as to form an angle with the blow-pipe. A moderate sized stream of glass is thus caused to flow onto the fire-clay shell at some suitable point back from the discharge end of the blow-pipe. Coming on at an angle and finding the clay-covered pipe rotating on an axis at an angle to its line of flow, the stream of glass winds onto the clay sheath. As the blow-pipe is also

dipped, gravitation aids in causing the glass to form a rotating envelope on the clay covering that continually loses glass at the lower end and gains glass continually from the trough. To form a tube, it is now only necessary to draw the glass continually away from the discharge end of the blow-pipe.

The size of the tube will turn on several things, among which are: (1) the amount of air put through the blow-pipe, (2) the temperature of the glass at the time it flows off the blow-pipe, (3) the speed of withdrawal of the glass from the blow-pipe, (4) the character of the glass itself.

There is a supporting trough or guide-way provided for the tubing coming from the furnace. This guide-way is a long affair as it must be long enough to permit the new tubing to cool to a proper point. The guide-way is essentially a long low frame-work supporting at intervals small wheels having grooved peripheries. The tubing lies in these grooves. The wheels are not driven by power, but are simply free to rotate as the tubing is drawn along over them. Every alternate support of the wheels in the guide-way may, if necessary, be provided with arms projecting upward on either side of the tube. These arms are to prevent the tube from riding off the wheels. They may be rods of wood covered with asbestos cloth.

At some considerable distance from the furnace and the blow-pipe a pulling device is located. This continually seizes the tube and pulls it along. It is necessary to locate it far enough from the furnace to have the tube stiff enough to withstand its action.

It was found in the experimentation preceding the grant of the patents that for tubing 3/16 inch in diameter a distance of 100 feet from the furnace gave satisfactory results, if the pulling was done at the rate of 140 feet per minute.

A refinement of the procedure already described consists in the use of a device for protecting the glass wound on the clay sheath over the blow-pipe from the direct heat of the special furnace in which the blow-pipe operates. This may be done by using a cylindrical muffle to envelop the glass. The exterior wall of the muffle then receives the direct action of the heat, absorbs it and transmits it mostly by radiation to the glass. This muffle may be so mounted as to permit of its rotation during service. The effect of rotation is to keep the muffle at a fairly uniform heat all round. This rotation of this hot muffle has to be specially provided for. One method of doing this is to provide two pairs of parallel shafts extending through the furnace wall and mounted in bearings outside. The shafts carry rollers or wheels and the muffle is placed on and between the two sets. One pair is needed for the front end of the muffle and one for the rear end. By operating all the shafts in the same rotational direction, the muffle will be turned.

The muffle may be given various forms. Thus, on the inside, for half the length from the rear, the wall may be conical. That is, the inner wall may taper down to near nothing at the amidships region of the muffle from a comparatively wide opening at the rear. Then for the forward half of the muffle, the interior wall may be an enlarged cylindrical surface. Finally, the outer wall may roughly follow these interior changes. The foregoing arrangements provide (1) for a limitation of the loss of heat from inordinate escape of gases between the blow-pipe sheath and the enveloping muffle and (2) for a slight cooling of the glass at the tip of the blow-pipe and just beyond in preparation for the emergence of the heated glass into the open air of the shop. This slight cooling has the effect of diminishing the fluidity somewhat and has been thought a desirable thing. Nevertheless, the invention has been practised with a form of muffle which did not provide for a preliminary cooling. That is, the interior of the muffle has a simple taper to the region of emergence into the shop air. The blow-pipe seems, however, to have been advanced further and in fact to have projected beyond the furnace wall a short distance. The muffle, whatever its precise form, may ordinarily be made of fire-clay or similar material.

The machine may be used to produce solid bar instead of hollow tubing, if desired. This may be done by simply shutting off the supply of pressure air. Or, a tip may be put on the end of the blow-pipe.

The air pressure used in blowing tubing is very slight—say, one or two ounces per square inch. With the machine, the blowing may be kept very steady, and this is understood to facilitate uniformity. This is claimed as a feature superior to the hand method, where the air pressure is probably of a fluctuating character. It is also claimed that machine drawn tubing, at least tubing drawn by this machine, is practically free from air bubbles. This advantage is thought to be probably due to the fact that the molten glass flows in a small stream onto the blow-pipe and that it winds onto it and flows onward in a thin film-like body down the pipe.

However, instead of a thin film flowing down the sheath onto the blow-pipe, a heavier amount may be maintained with the muffle. That is, assuming the muffle to have a simple taper on the inside, the glass may at the beginning be fed over-fast until the space between muffle and blow-pipe sheath is largely filled.

However, the inventor does not appear to especially favor having such a body of glass on the blow-pipe as to largely fill the muffle, but rather to prefer the management of affairs in such way as to provide an envelope of glass everywhere out of contact with the muffle, unless perhaps at the point where the interior of the muffle is most constricted. The thin sheath of glass best favors, it seems, the elimination of air bubbles.

The blow-pipe over which glass is caused to flow is not only set in a position inclined to the horizontal, but it is so mounted as to be rotatable, and this is understood to facilitate the performance of the operation. Moreover, by varying the degree of inclination, the process may be adjusted to the conditions at the time; such, presumably as the chemical constitution of the glass. Then, by steepening the inclination, the action of gravitation is accentuated; and by giving it less steepness, gravitation is checked.

(To be Continued)

Electrobestos, a composition containing asbestos, possesses characteristics that make it a valuable material for lehr rollers and other parts which come in contact with hot glass, and for carrying-in paddles, and similar purposes.

Notes on Glass*

Glass is a body which is won through the melting of basic substances (alkalies, earth alkalies and metal oxides) together with acids (silicic acid) in thin fluid state. It turns to a viscous and finally to a solid state. "Glass is a rigid fluid," says Dr. Keppeler, and these few words are the best definition of glass.

The chief constituent of glass is always silica whether of quartz glass, water glass, or of our ordinary glass. Quartz glass is pure silicic acid and is obtained in electric furnaces from quartz alone at high temperature. Water glass is a glass where silicic acid is combined with alkali and not simultaneously with alkaliferous earth or heavy metals. It is soluble in water. Our modern, that is our ordinary glass, however, which is in daily use in the household, in trade and in industry, is a glass in which silicic acid is always combined with two basic substances. The one is an alkali (potash, soda); the other an earth alkali (lime, barytes), or a heavy metal (lead-oxide, zinc-oxide).

The following table shows the composition of various glasses according to Coffignal:

	1	2	3	4	5
Silica	72.25	73.11	72.90	71.90	71.20
Soda	13.02	12.75	12.40	13.10	2.30
Potash	.....	.....	.....	.....	14.20
Lime	13.40	13.14	13.10	13.50	11.50
Alumina	1.23	1.83	1.50	1.40	0.70
Magnesia, iron, etc.	traces	traces	traces	traces	traces

Composition No. 1 refers to German Hollow Glass
2 " to Belgian Glass.
3 " to English glass.
4 " to French Glass.
5 " to Bohemian glass.

The specific weight of window glass is about 2.60, of bottles 2.80, of crystal glass 2.85, of plate glass 2.55, of lead-glass 3.30. The pressure which glass can withstand per square millimetre of surface and 1 millimetre thickness is 60 to 125 kilogrammes. A glass rod of 1 square millimetre section will break under a weight of 3½ to 8 kilogrammes. A rod of 1 metre length expands, on being subjected to warmth, only about 10 to 12 millimetres; glass with a high percentage of zinc, boric acid, magnesia and silicic acid, only about 6 millimetres. If the expansion of the glass is small, the tension which arises in the process of cooling down is also small, so that the glass possesses all the better resisting power when exposed to sudden changes of temperature.

Glass belongs with cotton, rubber, caoutchouc, wood, cork, quartz, sand and slate, to the bad conductors of heat.

Cotton	0.004	Copper	98.23
Caoutchouc	0.009	Silver	109.60
Cork	0.07		
Pine wood	0.03		
Hard rubber	0.02		
Glass	0.13		
Slate	0.08		
Quartz sand	0.013		

The numbers indicate the quantity of heat which passes per square millimetre of surface in one second through a plate of 1 millimetre thickness, the sides of which differ in temperature by one degree, expressed in milligrammes of calories.

The co-efficient of heat-radiation, according to Péclet's tests is as follows:

Glass	2.91	Copper	0.16
Building stone	3.60	Silver	0.23
Sand	3.62	Iron	3.17

Colorless glass, exposed for a considerable time to the rays of the sun becomes a bad color. When manganese is used such decolorized glass becomes yellowish or reddish; with nickel-oxide a greyish yellow, and with selenium exposed for a length of time to the sun rays, a clayey yellow.

Hard glass melts at a temperature of 1400 to 1600 degrees (Celsius); lead glass at 1000 degrees.

If glass is kept a considerable time in a fluid state and then slowly brought to a rigid state there results a so-called "devitrification." In the case of soda glasses this takes place more readily than in the case of potash glasses and with potash glasses more readily than with lead glasses.

Glasses containing alumina and boric acid are little or not at all inclined to this devitrification. If glasses are exposed to atmospherical elements, those which are imperfect and contain much alkali are subject to decomposition. The glass begins to "sweat," it takes on a whitish film as the alkalies disappear and the glass becomes "blind." The process is as follows: the aqueous vapor of the air decomposes the glass into silicic acid and alkali hydrate. The latter with the carbonic acid of the air turns into carbonates of alkalies (soda, potash) which form the film on the glass.

Imperfect glasses exposed to hot water give off considerable quantities of alkalies and silicic acid. The quantity after three hours' treatment with water of 80 degrees per square metre of surface, is, in the case of imperfect glasses, some 60 milligrammes of alkali, and in the case of good laboratory glass only some 0.4 to 1.24 milligrammes of alkali. Lead-glasses are in this respect better than the ordinary soda and potash glasses. Glasses containing zinc and alumina are distinguished by being but little liable to decomposition in water.

It is interesting to note that cut glasses are not so capable of resistance as uncut glass. Through the cutting the fire hardness imparted by the furnace is reduced. It is a peculiarity that the surface of the glass is harder than the interior parts of the same. The surface contains, as tests have shown, less alkali.

The film on the glass which does not come from the annealing furnace is generally to be removed by rubbing down. Glasses, however, which bear thick marks of the smoke from the annealing furnaces must be washed in a solution of water and hydrochloric acid or fluoric acid.

By means of a blow-lamp the glass can be roughly tested. One heats a fragment of colorless glass, free from lead, and a second fragment of colorless lead-glass. The former will remain unchanged while the latter becomes covered with a metal grey coating.

Ruby-gold glass, that is, glass which has been colored red

*Schnurpfeil's Review.

by means of gold, does not change under such a flame-test; ruby-copper glass, on the other hand, that is glass colored red by means of copper, assumes, on being heated, a clayey or colorless appearance.

Green glass containing chrome remains unchanged in the flame; but green glass which has received its color by means of copper becomes bronze-like.

If the glass is to be tested as regards its capacity for resisting atmospherical effects, the Weber process is tolerably reliable. The glass is exposed for 24 hours to the strong fumes of hydrochloric acid: for this purpose the glass is placed over a dish and a glass bell is thrown over the whole. From the whitish effect on the glass one can judge if the glass contains mûch or little alkali. Good glasses are insensible while glasses of inferior quality become slightly frosted.

Pyrometry in the Glass Industry

By R. P. BROWN*

(*Written for* THE GLASS INDUSTRY)

It was not so very many years ago that pyrometers were almost an unknown quantity in glass plants. Only a few of the more progressive and up-to-date plants in the country had any idea of the temperature which they were trying to maintain in the lehrs, flattening ovens, pot furnaces and melting tanks. In those days it was customary for the furnace man, or lehr tender, to squint into the furnace or lehr and endeavor to control the temperature, depending on whether he thought the furnace looked hotter or cooler.

Unfortunately, the furnace man would occasionally lose

BASE METAL THERMO-COUPLE.

considerable sleep for one cause or another, and would come in next morning with his eyes in poor condition to accurately judge temperature. He might guess that the temperature was almost anything along the whole temperature scale, and he very often couldn't tell whether the temperature was rising or falling.

It is no wonder, then, that pyrometers came to be rapidly

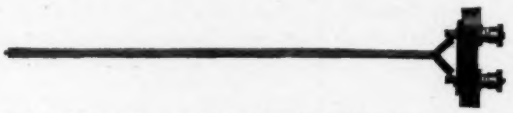
PLATINUM-RHODIUM THERMO-COUPLE WITH PORCELAIN TUBE OVER WIRES.

installed in glass plants and to-day there are few glass works in this country which do not control their temperatures by pyrometers. The day of the "hit or miss" method has gone by in the glass industry, and the glass manufacturers deserve a lot of credit for the progress they have made along this line.

Strange to say, there are other industries where temperature plays a very important part, which are twenty years behind the glassmakers of to-day in their ability to control their temperatures. The glass and steel industries have been most progressive in this respect.

Originally, an expansion form of pyrometer was used in glass plants. The instrument used on the lehrs consisted of a dial and a stem, comprising a steel tube, and inner rod of graphite or carbon, or similar non-expansive material. The instrument indicated temperature, depending on the relative increase in expansion of the steel stem and the graphite rod. For higher temperatures in the melting furnaces, an instrument was used in which a strip of platinum expanded rapidly on immersion in the high heat.

About fifteen years ago thermo-electric pyrometers began to come into use and these instruments have practically replaced the older form of expansion pyrometer. The thermo-electric pyrometer consists of a thermo-couple, a measuring instrument, and the wires connecting the thermo-couple to the instrument. The thermo-couple is formed of two wires



PLATINUM-RHODIUM THERMO-COUPLE WITHOUT PORCELAIN TUBE.

of dissimilar materials; for example, one wire of iron and the other of copper. When the junction of any two dissimilar wires is heated, a small current of electricity is generated. This current is very small and is measured only in millivolts or thousandths of a volt. A sensitive form of voltmeter is used to measure this small current. No outside source of electricity is required, as a thermo-couple generates its own voltage, depending on the temperature to which it is heated.

In the past few years, tremendous strides have been made in the development of alloys which are exceedingly heat-resisting, as this is essential in the production of thermo-couples. For use in lehrs and ovens, thermo-couples of base metal are used, either one wire of iron, the other constantin, a nickel-copper alloy, or a thermo-couple of nickel-chromium, which is somewhat more heat-resisting than the iron-constantin thermo-couple. These thermo-couples are protected with a steel tube for temperatures up to 1400° F. or 750° C.

For measuring the temperatures in the pot furnaces and melting tanks, we must use a thermo-couple of more heat-resisting material. The thermo-couple which has been adopted consists of platinum and platinum-rhodium wire. This thermo-couple has a melting point of 3,000° F. The life of the thermo-couple is dependent entirely on the protection of the platinum wires from the action of gases. On

*President, Brown Instrument Company.

this account it is necessary to use an impervious porcelain tube over the thermo-couple wires. In addition, it is customary to use an outer protection of firebrick, carborundum, or similar material. Provided the thermo-couples are properly protected, carefully installed and not abused, they will give excellent results and maintain their accuracy for a long time.

Tremendous strides have been made in improvements in the instruments with which the voltage of the thermo-couple is measured. These instruments have been so perfected that the temperature can be measured accurately at 2,000 or 3,000 feet distant from the lehrs or furnaces. I know of one plant where recording instruments record the temperature day and night in the office, at a distance of not less than 2,000 feet from the lehrs and furnaces in the factory.

INDICATING PYROMETER.

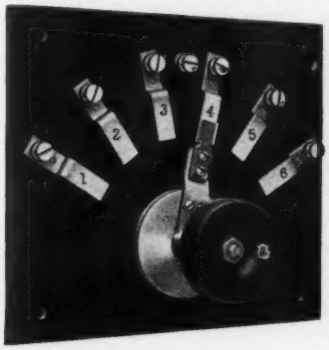
These instruments have been so developed and perfected that indicating instruments can be furnished the operator for his guidance in the factory and recording instruments will keep a continuous record of the temperature for the management in the office. Both instruments work simultaneously off the same thermo-couple.

Many different types of recording instruments have been developed and these are now available to make a record on a circular chart, or they are furnished to keep a record on a continuous strip of paper, lasting two or three months, or more. This paper is torn off, daily or weekly, as preferred.

Multiple recording pyrometers have been developed which will keep a record of a number of furnace or lehr temperatures on one chart, for easy comparison. The multiple recorder is most suitable where the temperatures are not ordinarily close together and where the temperature lines do not intermingle. However, to assist in reading the temperatures on multiple recorders, the different lines, representing thermo-couples, are shown in different colors or with different symbols.

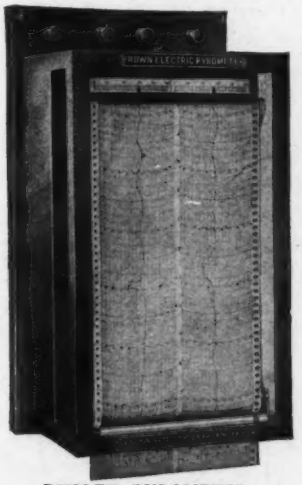
The automatic control of temperature in the glass industry is the next step. Automatic valves are available to-day to work off an automatic control pyrometer. These valves will control air, oil and gas. They are also built to control air and gas, or oil and air, simultaneously. Automatic control pyrometers, to operate on electrically heated lehrs or ovens, are a comparatively easy proposition, as it is only necessary to provide for opening and closing an automatic switch through the pyrometer.

As the glass industry has shown such a progressive attitude in the past in solving its temperature problems, I believe it will only be a few years before the automatic control



SINGLE POLE ROTARY SWITCH.

of temperature in glass plants will be considered common practice. When the temperature in each lehr can be controlled by the pyrometer for a certain class of ware, it will then be possible to control the lehr temperatures, constantly, within ten degrees, plus or minus. When the furnace tem-



DUPLEX PYROMETER.

peratures are controlled with an automatic pyrometer, it will be possible to control the furnace temperatures within twenty degrees, plus or minus, or closer if necessary.

Just imagine what a relief it will be to the manager of a plant when automatic temperature control on the lehrs and furnaces becomes a reality. There will be no worry because Jake is off sick for the day and Joe does not know how to run the furnace or lehr the way Jake does. Automatic temperature control will eliminate the human element and another real step forward will have taken place in the glass industry.

Central Bureau for Impoving Fuel Conditions Established by the Association of German Glass Manufacturers

By WM. M. CLARK*

(*Written for* THE GLASS INDUSTRY)

It is rather interesting to glass men to learn of a recent new departure on the part of the Association of German Glass Manufacturers of Frankfort-on-Main in a co-operative direction in incorporating for their mutual benefit a Central Advisory Bureau for Technical Advice and Consultation on Matters Pertaining to Heat and Fuel. The economic position of the glass industry in that country has attained special attention because it utilizes native raw materials and does not have to rely on imported supplies and at the same time has exhibited a considerable volume of trade in glass manufactured products exported. Most of the German industries are not in such a favorable position, as they have to rely largely on imported raw materials from foreign countries and the unfavorable exchange rate of the mark is a serious matter in such transactions. Commercially, Germany is today largely a country of "frozen credits" and therefore industries that can be supplied from her own soil, supply the domestic market and export their surplus are in favor with the banks and financial interests.

Fuel is the one raw material used in the glass industry of which there is a shortage in Germany today. Therefore the manufacturers have organized this central bureau with nine of their representatives from the different production centres on its advisory board to study and report on the fuel situation. These have chosen Dr. Quasebart, an engineer, as director of the bureau. They are attempting to evolve from a definite method of allotment an increased efficiency in the utilization of fuel in the glass industry.

This Glass Fuel Supervisor's Office has affiliated with the Large Fuel Consumers' Association, Berlin, in order to obtain consideration for glass plants that have had to close because of fuel shortage and for the financial and official influence accruing from membership in the powerful central organization.

Specifically the efforts of the bureau are directed towards advising as to practical methods for consuming every kind of fuel and the utilization of heat therefrom to the best advantage. Its functions are purely advisory and the endeavor is to disturb conditions at a plant as little as possible but to get the most efficient results obtainable from existing equipment.

The fundamental idea is that entire heat value in any combustible material should be utilized with the utmost degree of efficiency.

Among the most important problems in matters pertaining to fuels are: Investigation and valuation of fuels on the market and specifications as to which purpose they are most suitable. Survey of the low heat value fuels, for example, brown coal. Selection of the best adapted method of firing, such as direct firing, gas firing, recuperative furnaces. Gasification of coals and choice of the best adapted generators; recovery of by-products, tar, ammonia, etc. Elimination of losses due to leaks and radiation. Utilization of the waste heat in the flue-gases from the furnace and lehrs.

An effort will be made to determine to what degree present installations are adaptable to various grades of fuels; whether it is only necessary to make a simple change in furnace arrangements in order to utilize low grade fuels. Or if some simple construction changes in some parts are all that is required for this result. Or whether considerable changes with partial or complete new construction are essential.

In order to carry on such investigations it was necessary to supply the technical staff with suitable equipment and facilities. The majority of smaller plants pay no attention to the investigation of their coal supply. A plant manager can only judge the value of a fuel if he has some essential measurements under operating conditions. For this purpose some simple low cost equipment requiring no special training to utilize is all that is necessary.

The measurement of gas temperatures and gas pressures at different positions in a furnace is especially valuable in giving an idea of the performance of a furnace. Observation of the gas analysis gives a criterion of producer operation and leads to obtaining a smooth-running furnace. Disturbances arising from careless attention to the reversal valves, leaky valves, stoppages arising from flue ashes or batch dust, are quickly noted and watchful supervision and suitable equipment are employed.

Recording instruments are especially commendable as they make the observations independent of the presence of an observer. Exact control of the most advantageous temperatures in the melting and tempering furnaces can be achieved with essential economies.

Some of the more complicated and expensive instruments require the attention of experienced technical men and therefore the bureau has some district engineers who can divide their time among the plants in their districts making observations and endeavoring to achieve economies in the utilization of fuel.

It also provides at the headquarters in Frankfort facilities and instructors for teaching men sent from the different glass plants how to use various types of instruments and the importance of the best operating conditions; also a place for the calibration and standardization of meters and instruments.

*Glass Technology Department, National Lamp Works of General Electric Company, Nela Park, Cleveland, O.

Approximate Temperature by Colors

	Degrees	
	Centigrade	Fahrenheit
First visible red	525	977
Dull red	700	1292
Cherry red	900	1652
Dull orange	1100	2012
White	1300	2372
Dazzling white	1500	2732

German Patents on Glass Compositions

By ASHER BLUM*

(*Written for* THE GLASS INDUSTRY)

The practice of the German concerns in the glass industry appears to have been to keep their compositions and methods of manufacture secret, because the German patents on glass compositions or methods of manufacturing glass are few in number. For example, the Jena Glass Works did not take out any patents whatever for any special compositions of glass or for any special methods of handling it.

From 1885 to 1914 only 29 German patents were granted upon the before-mentioned points and these relate mainly to methods or compositions for coloring or decoloring glass.

The compositions or methods for producing the so-called milk glass have been discussed in a previous article.† In addition to these patents the following may be of interest:

No. 63,558. Process for producing rose-red and orange-red glass. Welz. August 24, 1892.

Selenium alone, or mixed with cadmium sulphide is added. In the first case a rose red color, in the second case an orange red color is produced.

No. 73,348. Process for making a glass that has an orange-yellow color in transmitted light, and a greenish color in reflected light. Welz. March 21, 1894.

This is an addition to German patent No. 63,558.

According to the main patent, selenium and cadmium sulphide are added to the glass in the pot to produce an orange red glass.

The cadmium sulphide is now replaced by uranium oxide.

No. 74,565. Process for imparting a red color to glass by means of selenites and selenates. Spitzer. June 6, 1894.

This refers to the process of German patent No. 63,558. A selenite or selenate (of potassium, sodium, or calcium) is added to the molten glass and the coloring selenium separated out by a known reducing agent as arsenious acid, etc.

No. 77,737. Process for imparting a red color to glass by means of selenium compounds. Spitzer. December 12, 1894.

This is an addition to German patent No. 74,565. Selenium is now added to the glass instead of selenites and selenates. To secure new shades, gold, silver, coloring metallic oxides, bone, cryolite, etc., can be added.

No. 88,441. Process for producing a copper-ruby glass of any desired gradation of color. Goerisch & Company. October 14, 1896.

Antimony is added to copper-ruby glass of any desired composition to reduce the copper oxide found in the glass in the metallic state.

No. 88,615. Process for decolorizing glass by means of selenium and selenium compounds. Richter. November 4, 1896.

Selenium or its compounds impart a rose red color to glass according to German patents No. 63,558 and No. 74,565, when added in large quantities, but very small quantities thereof serve to decolorize glass. From 1-5 gr. of selenium are sufficient to decolorize a mass of glass to which 100 kg. of sand have been added.

The preliminary decolorizing of the glass can also be accomplished by the usual substances, as manganese and saltpeter, and then the highest grade of white produced by selenium or its compounds.

No. 103,441. Process for decolorizing glass. Drossbach. July 19, 1900.

Compounds of neodymium or erbium containing small quantities of cerium and praseodymium are added to the glass. The blue-green color of ordinary glass is removed by the rose red color of the erbium or neodymium.

No. 108,595. Process for decolorizing glass according to German patent No. 88,615. Moser. April 19, 1900.

This enables the glass to be decolorized with certainty, and to then have a superior polish.

A mixture of 30 parts (by weight) of manganese dioxide, 25 parts of selenium, 20 parts of bismuth oxide, 15 parts of nickel hydroxide and 10 parts of arsenious acid is used. This may be mixed with a batch of glass and added to the molten glass.

No. 133,502. Process for imparting a red color to glass by means of carbon. Meurer. September 10, 1902.

Carbon in the form of carbon black is added to the glass. To prevent the creation of dust, the carbon black is pressed together, preferably with the addition of a binder, as sugar solution, etc. The pressed mass is ground to a powder which does not form dust, and is thus added to the glass. The carbon black can also be saturated with melted alkaline salts or aqueous solutions thereof, and added to the glass after drying.

No. 138,281. Process for making heavy gold-ruby glass from batches of glass containing barytes. Zsigmondy. February 11, 1903.

Enough dissolved or finely divided gold is added until 10,000 parts of sand have from 0.25 to 1.7 parts of gold by weight. Then the materials are melted in the glass furnace. Sodium is suitable as the chief alkali, and barytes may be employed. A reducing means may be employed during the melting.

No. 162,607. Process for decolorizing masses of glass. Kersten. October 11, 1905.

The decolorizing is accomplished by titanium compounds and a reducing agent.

No. 182,266. Process for manufacturing dark glass from brown coal ashes. Allendorff. May 8, 1907.

The ashes are mixed with water in tall vessels so that their constituents separate in layers, according to their specific gravity. The magnesium compounds and clay are removed and the remaining mixture of iron oxide and lime as well as the necessary sand and other ingredients are made into glass.

No. 193,420. Process for producing dark glass. Allendorff. February 19, 1908.

This is an addition to German patent No. 182,266. Peat ashes are subjected to the separation by the water instead of the brown coal ashes.

*Of Mock & Blum, patent attorneys.
†Milk or Alabaster Glass. THE GLASS INDUSTRY, April, 1921, p. 84.

The Laboratory

By J. B. KRAK

Technology and Analysis of Potash

Potash, or potassium carbonate, was originally obtained from the ashes of wood, hence the name "pot ashes." It is used in place of sodium in the manufacture of lead flint glass, which is a potassium-lead glass and in Bohemian glass, which is a potassium-lime glass. Much of the commercial potash is now made from potassium chloride by the Leblanc process. The ammonia or Solvay process cannot be applied because potassium bicarbonate is soluble in ammoniacal solution and does not precipitate as is the case with sodium bicarbonate. It is sold in trade under the name of pearl ash; the crude salt, obtained from wood ashes, is usually designated as potash.

In the Leblanc process the chloride of potash is first converted into sulphate by treatment with sulphuric acid in a way similar as described in the manufacture of salt cake. The potassium sulphate is mixed with limestone and powdered coal, and heated in a revolving furnace. The following reaction takes place:

$$K_2SO_4 + CaCO_3 + 2C = K_2CO_3 + CaS + 2CO_2$$

Potassium sulphate — Limestone — Coal — Potash — Calcium sulphide — Carbon dioxide

The "black ash," obtained by this operation, is a brownish black or dark gray substance. It is leached with water at a low temperature in a series of tanks. The solution thus obtained is allowed to stand until the suspended matter has settled out. It is then pumped to the top of carbonating towers, in which the tank liquor trickles over porous material and comes into contact with a current of carbon dioxide, entering at the bottom and passing through the tower. Caustic potash, present in the liquor, is converted to carbonate, while impurities such as iron, aluminum and silica are precipitated. The carbonated tank liquor is evaporated in semi-cylindrical evaporating pans, provided with mechanical scrapers, which prevent the salt from adhering to the pan.

The purity of potash depends on its origin and method of preparation. It may contain soda, chlorides, sulphates and insoluble substances. Soda is undesirable if the potash is used to produce pure crystal glass. Its presence must, of course, be taken into account in the preparation of sodium-potassium glass. Chlorides and sulphates may cause cloudiness in glass. The insoluble constituents may introduce aluminum and iron. For the highest grade of crystal glass the latter element should be practically absent, and amount to less than 0.02%.

Impure potassium carbonate, derived from wood ashes, molasses and beet ashes, contains as a rule potassium phosphate in addition to the impurities mentioned above. The phosphate is an important indicator of the origin of the material. Other constituents that may occur are potassium hydroxide and various sulphur and cyanogen compounds.

ESTIMATION OF IRON.—Weigh a 5 gram sample and dissolve in dilute hydrochloric acid in slight excess. Add 3 grams of potassium iodide, allow to stand 20 minutes and titrate the liberated iodine with N/20 sodium thiosulphate solution.

$$1cc\ N/20\ Na_2S_2O_3 = 0.080\%\ Fe_2O_3$$
$$1cc\ N/20\ Na_2S_2O_3 = 0.056\%\ Fe$$

ESTIMATION OF POTASSIUM CARBONATE AND TOTAL ALKALI.—Weigh 3.455 grams of the sample, dissolve in water and add a few drops of methylorange. Titrate with N/1 sulphuric acid.

$$1cc\ N/1\ H_2SO_4 = 2\%\ K_2CO_3$$
$$1cc\ N/1\ H_2SO_4 = 1.363\%\ K_2O$$

ESTIMATION OF POTASSIUM CHLORIDE.—Dissolve from 2-10 grams of the sample, according to the chlorine contents, and dissolve in water. Add a drop of methylorange and add nitric acid until neutrality. Add a few drops of potassium chromate indicator and titrate with N/20 silver nitrate solution until the appearance of a permanent reddish tint. Deduct a blank of 0.2 cubic centimeters.

$$\frac{cc\ N/20\ AgNO_3 \times .3728}{\text{weight of sample}} = \%\ KCL$$

ESTIMATION OF POTASSIUM SILICATE.—Weigh a 10 gram sample and transfer to a porcelain dish. Dissolve in dilute hydrochloric acid, evaporate to dryness, add a few drops of concentrated hydrochloric acid and again evaporate to dryness. Heat in a drying oven at 120° C. for one hour, treat with hot dilute hydrochloric acid and filter. Wash with hot water, and weigh as SiO_2.

$$\text{Weight of } SiO_2 \times 25.62 = \%\ K_2\ SiO_3$$

ESTIMATION OF POTASSIUM SULPHATE.—Heat the filtrate from the silica determination to boiling and add 10% barium chloride solution in slight excess. Allow to stand several hours, filter and weigh as $BaSO_4$.

$$\text{Weight of } BaSO_4 \times 7.465 = \%\ K_2\ SO_4$$

ESTIMATION OF SODIUM CARBONATE.—Transfer the filtrate from the bariumsulphate to a one liter flask, dilute to the mark and pipette 100 cubic centimeters, containing one gram of the sample, to a beaker. Add enough of a saturated solution of ammonium carbonate to precipitate the barium, filter and evaporate to dryness in a porcelain dish. Drive off the ammonium salts by heating over an open flame, take up with water and filter into a weighed platinum dish. Heat gently and weigh the combined chlorides of potassium and sodium. Dissolve in water, transfer to a small porcelain dish and add platinic chloride solution in excess. Evaporate to a syrupy consistency, add 85% alcohol and filter on a weighed Gooch crucible. Wash with alcohol, dry at 130° C. and weigh. Calculate to potassium chloride and deduct the weight from the amount of combined chlorides found previously. The difference is the sodium chloride derived from the sodium carbonate of the sample.

Factors: $K_2PtCl_6 \times 0.3068 = KCl$

$NaCl \times 0.9066 = Na_2CO_3$

ESTIMATION OF PHOSPHORIC ACID.—Dissolve a 5 gram sample in dilute nitric acid, add 10 grams of ammonium nitrate, heat to 60° C. and add ammonium molybdate in excess. Allow the precipitate to settle, filter, and wash with cold water. Return the filter and precipitate to the beaker in which the precipitation was made, and from a burette add an excess of N/10 sodium hydroxide. Break up the filter with a stirring rod, add a few drops of phenolphthalein indicator and titrate the excess of alkali with N/10 nitric acid.

This method is based on the acid character of ammonium phosphomolybdate. The following reaction takes place with an alkali hydroxide:

$$2(NH_4)_3\ 12Mo_3PO_4 + 46\ NaOH + H_2O = 2(NH_4)_2\ HPO_4 + (NH_4)_2\ Mo_4O_4 + 23\ Na_2\ Mo_4O_4 + 23\ H_2O$$

From the reaction 46 molecules of sodium hydroxide are equivalent to one molecule of P_2O_5. One cubic centimeter of a N/10 solution of alkali hydroxide neutralizes the yellow precipitate containing an equivalent of .000309 gram of P_2O_5. This explains the great accuracy of the titration method for small amounts of phosphoric acid.

cc N/10 NaOH — cc N/10 HNO_3 × 0.00618 = % P_2O_5

Bureau of Standards Notes

In the process of annealing optical glass, it is very difficult to completely free large blocks of glass from internal stresses. An investigation has been started by the Bureau of Standards in order to determine the effect of slightly strained glass on the performance of an optical system. Prisms having various amounts of strain are introduced into an otherwise good optical system and the effect of the strain is observed. After the magnitude of the strains have been measured, it is hoped that some relationship may be found between the stresses and the effect on the definition of the instrument in which the glass is used. Thus, it may become possible to specify the minimum tolerance for strain in optical glass.

Bureau of Standards Circular 110 on the subject of specifications for marine sextants cover the rigidity, durability, convenience of operation, and mechanical perfection of the instrument; range and accuracy of the scales; consistent tolerances for the mirrors, shade glasses, and telescopes, and provisions for adjustment and replacements.

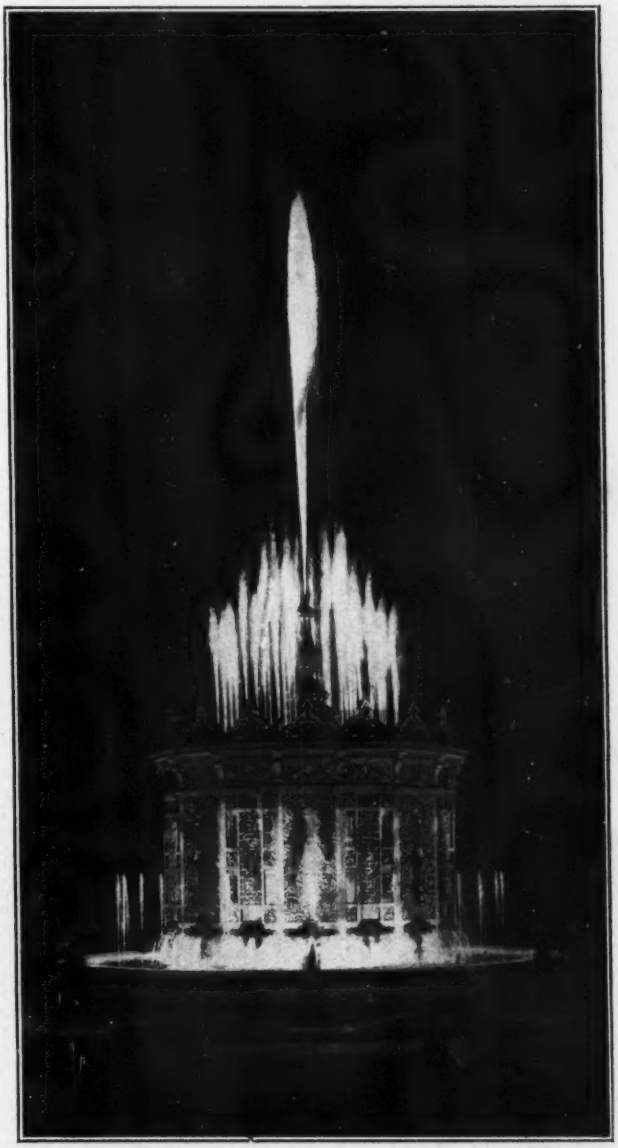
A five-inch lens of 20½ inches focus furnished by the Bureau of Standards to the Navy Department for some special work was found to be superior to a very expensive quadruple lens which was also tried for the same purpose.

Glass Research Fellowship

The fellowship for the study of the viscosity and electrical conductivity of molten glass at high temperatures maintained under the regulations of the National Research Council by the Corning Glass Works, Corning, N. Y., is held by G. B. Shelton, who is carrying out the experimental work in the Department of Ceramic Engineering at the University of Illinois. Under the regulations governing this fellowship, the holder receives a stipend of $800 for the first year and $1,000 for the second and subsequent years and has the privilege of doing his research work at a university, of becoming a candidate for an advanced degree at that university and of taking such advanced courses as may be necessary thereto. The publication rights to the results of the investigation are vested in the institution in which the research work is conducted, with the understanding that all results shall eventually be published for the free use of the public.

Beautiful Glass Fountain for India

This handsome illuminated fountain for installation in the palace garden of the Maharajah of Mysore, India, was designed by W. D'A. Ryan, founder and originator of the illuminating engineering laboratory of the General Electric Company, Schenectady, N. Y. The central structure is to



Photo, Courtesy of General Electric Company. Drawn by Joseph W. Gosling.

be of translucent glass lighted from within by colored G-E Mazda lamps, while vari-colored rays from concealed sources will be projected through the glass covered base on the falling waters, producing for the observer the most beautiful and mysterious effects.

Japanese Soda Industry

About seventy factories with capital aggregating $87,000,000 are engaged in the soda industry in Japan. The output includes soda ash, Glauber's salts, Na_2S, NaOH, HCl and bleaching powder.—*Journal of Chemical Industry*, Tokyo, vol. 22, pp. 997-1008, 1919.

The Glass Industry

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NEW YORK, MAY, 1921

Holding Up Our End of It

The Society of Glass Technology of England at the close of 1920 had a total membership of 620, consisting of 143 collective (or firm) members, 469 ordinary, and 8 student members. During 1920, 128 new members were elected.

The entire membership of the Glass Division of the American Ceramic Society is, we believe, less than one-fourth that of the British organization.

If the intensity of interest displayed in the fundamental principles underlying manufacturing processes may be taken as a criterion of the progressiveness of those engaged in an industry such as glass making, then the comparison made above becomes significant, for it indicates that England, possessing many less glass factories than the United States and with a decidedly smaller volume of business at stake, is much more deeply interested in the development of her glass trade along scientific lines than we are in ours. It may be said that British glass manufacturing methods are less advanced and therefore in greater need of improvement than ours. But this does not altogether account for the widespread interest manifested in the work of the Society of Glass Technology.

It has been apparent for some time that the British glass manufacturers, having been forced by the war out of the rut they were in, have seen a great light and will leave no stone unturned in their efforts to build up their industry on a firm foundation of scientific knowledge. Evidence of this determination is found in the subsidization of the Glass Research Association by the British government and in the establishment of excellent technical educational facilities for those desiring to enter the industry.

The activities of our British friends should concern those numerous American manufacturers who still are inclined to underrate the importance of chemical research and technical control of manufacturing processes and prompt them to look to the future as well as the present and to give support to and take an active part in all worthy and well-directed efforts for the betterment and extension of our own industry, to the end that its pre-eminence may always be maintained.

Books Received

THE PLATE AND SHEET GLASS CALCULATOR

Compiled by Samuel S. Lindsay, published by the Pittsburgh Plate Glass Company, Pittsburgh, Pa. 1917 edition.

Countless hours of weary work have been saved those whose business necessitates the calculation of superficial areas of sheet and plate glass, by this book. The sum total of the time and energy it has conserved would reach an enormous figure. Tabulated in the book in convenient form for quick reference purposes are about 28,000 superficial areas, enabling one to ascertain directly from the table the area of any piece of glass measuring from 1 inch by ¼ inch up to 239 inches by 120 inches. Concise examples and instructions are given for using the tables for determining the areas of any number of lights of any size.

INORGANIC CHEMICAL SYNONYMS AND OTHER USEFUL CHEMICAL DATA, by Elton R. Darling, M. S., Ph. D. Published by the D. van Nostrand Company, size 7¼x4½, 100 pages. Price $1.00.

Nothing could better demonstrate the difference between the vocabulary of the professional chemist and that of the manufacturer and trader than a perusal of this volume. The need for a dictionary which translates the language of science into the vernacular, and vice versa, has repeatedly manifested itself, and it is believed that this book will prove itself useful to all who are interested in chemicals. The volume contains a number of tables. Among them a list of the elements, with their discoverers and the dates of discovery is especially interesting. The publishers have succeeded in putting out an attractive looking volume in spite of its low price.

Technical Consultation Service

THE GLASS INDUSTRY invites its readers to refer to this department any problems with which they may be confronted pertaining to raw materials, glass technology, laboratory and factory practice. While making no pretensions to the possession of unbounded knowledge or infallibility THE GLASS INDUSTRY is ready to assist its readers to the best of its ability in solving their problems. Readers who can offer better suggestions are invited to submit them.

Answers to all questions will be made by mail as promptly as possible. The source of all inquiries will be held in strict confidence.

QUESTION 8—One of our customers in South America is very much interested in getting into the manufacture of electric insulators and has asked us if we could give him a formula for a good insulator batch. We would thank you very much, if you have one at your command, to kindly send same to us.

ANSWER—The following batch is used to make glass articles by the machine process, and will undoubtedly be also applicable to insulators.

		Calculated Analysis	
Sand	100 lbs.....	Silica (SiO_2).....	73.05%
Soda ash	44 lbs.....	Sodium Oxide (Na_2O).	18.77%
Limestone	20 lbs.....	Calcium (CaO)	8.18%
		Total.....	100.00%

Glass insulators, used by the telephone and telegraph companies, are usually made of greenish looking glass, due to impurities in the raw materials. Yellow sand, and rather impure limestone can be used.

The following batch yields high grade, white insulators, but we do not believe it has ever been used in connection with machines.

Sand	100 lbs.
Soda ash	30 lbs.
Feldspar	35 lbs.
Fluorspar	35 lbs.
China clay	10 lbs.
Cryolite	2½ lbs.

This, of course, is a batch which resembles those used for illuminating glassware. The batch can be melted in a continuous tank furnace.—J. B. K.

QUESTION 9—What materials are used in producing a high lustre upon plate glass besides putty powder and finely divided red oxide of iron? Are the materials mentioned mixed with water or alcohol, or what other fluid is used?

ANSWER.—In addition to the materials mentioned in this question, tin oxide is sometimes used. The best results are obtained with red oxide of iron, which is mixed with water. —J. B. K.

Frosted Glass

A frosted appearance may be given to glass or mirrors by covering with a mixture of

Magnesium sulphate (Epsom salts).....	6 parts
Dextrin	2 "
Water	20 "

When this solution dries, the epsom salts crystallize in long, fine needles. Instead of dextrin, beer can be used.

The glass surface should be clean and dry before the application is made. The crystals can be removed with lukewarm water.

Telescope Lens Arrives From Germany

The Alvan Clark Company of Cambridge, Massachusetts, has recently received a pair of 21-inch disks for the new lens for the Van Vleck Observatory of Wesleyan University, Middletown, Connecticut.

The glass was ordered from Schott & Company of Jena, Germany, in 1914, just before the war broke out, but during the war that firm was devoting all its energy to making glass for range-finders, periscopes, etc. It was not until the summer of 1920 that the Wesleyan disks were poured.

The lens will be figured and ground by the Alvan Clark Company and it is hoped that it will be finished and installed in the observatory early in the fall. The lens will have a clear aperture of 20 inches and focal length of 28 feet.

The mounting for the new lens was made by the Warner & Swasey Company of Cleveland, Ohio, in 1915. Since that time a 12-inch lens of 15½ feet focal length has been used in the new tube, pending the completion of the larger glass.

New Publications

NATIONAL ELECTRIC SAFETY CODE.—Handbook No. 3 of the Bureau of Standards, has recently been published and may be obtained from the Superintendent of Documents, price 40 cents. This new edition is a book of pocket size, and the discussion of the rules has been segregated in a separate volume, which will appear later as Handbook No. 4.

In addition to two introductory sections giving definitions of terms and rules for the grounding of apparatus and circuits, the code consists of four principal parts, as follows:

(1) Rules for the installation of machinery, switchboards and wiring in central stations and substations; (2) rules for the construction of overhead and underground lines for the transmission and distribution of electrical energy and intelligence; (3) rules for the installation of electrical apparatus and wiring in factories, residences and wherever electricity is utilized for light, heat or power; (4) rules for safeguarding employees when working near electrical machines or lines.

NATIONAL SAFETY CODE FOR THE PROTECTION OF THE HEADS AND EYES OF INDUSTRIAL WORKERS. Bureau of Standards Handbook, Series No. 2. First Edition. 64 pages. Price, 10 cents. For sale only by the Superintendent of Documents, Washington, D. C.

This code was developed by the Bureau of Standards in cooperation with the American Engineering Standards Committee, the National Safety Council, and a committee representative of various other bodies, including state industrial commissions, insurance interests, etc. Among those serving on the advisory committee were C. H. Kerr, formerly of the American Optical Company, and Max Poser, Bausch & Lomb Optical Company.

The code first presents the general requirements, scope and application of the rules, including a classification of the occupations requiring eye protection. Then follows the detailed requirements for each group, operating rules, and finally the specifications for tests which must be met to insure that protectors will adequately fulfill their purpose. The general requirements for glass for lenses and windows of head protectors are included, also specifications and mechanical and optical tests for lenses.

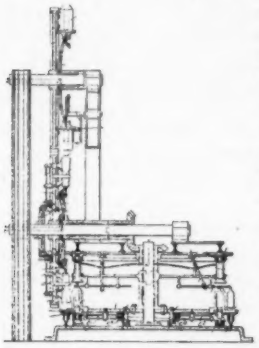
Personal

IRVING E. ADAMS, who for some time has been superintendent of the Federal Glass Company, Columbus, Ohio, has resigned and is open to an engagement along technical or executive lines. Mr. Adams is located at 285 Seventeenth avenue, Columbus, Ohio, where he is at present engaged in consulting work.

Patents

RECENT INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Apparatus to Be Employed in the Manufacture of Hollow Articles of Glass. U. S. 1,371,085. March 8, 1921. Alexander Ferguson, of Scorrier, England, assignor to Francis William Passmore, of London, England. This invention consists of an improved apparatus by which hollow articles of glass can be manufactured with ease, rapidity, and economy, and in such manner that the articles produced are of very good quality.

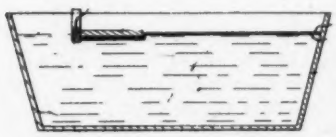


According to this invention cylinders, or receptacles, are arranged at intervals around a rotatable wheel with their openings at the periphery of the said wheel. In each cylinder, or receptacle, is a piston, or plunger, which, by any suitable means, as the wheel rotates, will be moved inward when the open end of the cylinder, or receptacle, becomes submerged in molten glass in the forehearth, or other suitable vessel, containing molten glass, and thereby a charge of such glass is drawn into the cylinder, or receptacle. The said wheel rotates continuously, or intermittently, and the pistons, or plungers, retain the molten glass in the cylinders, or receptacles, until they come opposite a passage leading to the periphery of another rotatable wheel containing a circular series of peripheral molds in which the articles can be molded to, or partly to, the required shape and then the said pistons, or plungers, are operated to expel the contents of the cylinders, or receptacles, into the said molds.

For bottle making, for which this apparatus is especially suitable, the bottle-neck will be formed in the molds carried by the aforesaid second wheel and a third wheel, furnished with molds to form the bodies of the bottles, is mounted to rotate in proximity to the periphery of the second wheel and as these body-molds are presented to the neck-molds of the second wheel the plastic glass bottle blanks will be removed from the said neck-molds into the molds of the third wheel to be blown to bottle shape. Any suitable gear may be employed whereby the movement of the pistons in the first wheel and the supply of compressed air as required will be properly regulated.

Method of Ornamenting Sheet-Glass. U. S. 1,375,251. April 19, 1921.

This invention relates to a method of ornamenting sheet glass. Suitable coloring matter is placed on the surface of the liquid by a brush which is struck by a pallet knife or equivalent and which throws or scatters liquid paint on the level of the water. This paint may be any color or colors. Gold paint, bronze paint, black paint, or any other suitable shade is then thrown onto the surface of the water. A creamy body such as Batavia gum is then put on the surface of the liquid after the paints. This forms designs or veined effects on the surface of the water, this being brought about by the gum or creamy mass which causes the colors to assume vein forms and prepares it to color or ornament an object which as will be inferred is usually glass. The glass to be colored is if necessary dried on its surface and is then dipped into the water the proper depth to take on its submerged portion, the necessary colors from the surface of the water, and after being removed is dried artificially or naturally. Subsequently the coated surface is given its final coat by spraying or brushing; this brushing or spraying holds the ornamented coat to the surface in a permanent and substantial manner.



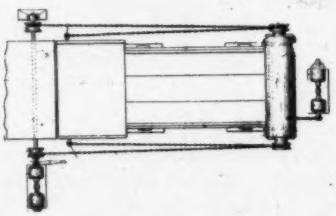
Refractory Insulation. U. S. 1,374,538. April 12, 1921. Paul G. Willetts, of Fairmont, West Virginia.

This invention relates to refractory insulations for furnaces, boiler settings, retorts, kilns, ovens, flues, linings, floors, walls, ceilings, and the like.

One object of this invention is to provide compositions of matter for manufacturing refractory insulation. Another object of this invention is to provide methods by which such compositions may be made into articles having predetermined degrees of refractoriness and heat insulation. This material is satisfactory for all kinds of glass-house refractories or flux resisting materials, bricks of all kinds used in coke-ovens, furnaces, boiler-linings, flue-linings, chimneys, flues, conveyors of heat, and the like.

Machine for Rolling Plate-Glass. U. S. 1,375,014. April 19, 1921. Harry A. Reynolds, of Ford City, Pennsylvania, assignor to Pittsburgh Plate Glass Company, a corporation of Pennsylvania.

The invention relates to apparatus or machines for rolling glass, such as employed in the manufacture of plate glass. The invention has for its principal objects the provision of an improved arrangement whereby the roll employed is prevented from being unequally heated between the operation of rolling successive sheets. In rolling mechanism as heretofore employed the proximity of one side of the roll to the table and the casting of the glass against the roll has caused such unequal expansion that the roll bulged appreciably, and when operated to roll out a sheet of glass produced an uneven thickness in the sheet. This difficulty arises not only with a solid roll but also with a water cooled roll, which latter, however, is distorted to a less degree. The present invention is designed to overcome or minimize this trouble, and briefly stated, this is accomplished by providing means for supporting the roll for rotation at the end of the table and providing means for rotating the roll in such position intermediate successive operations.



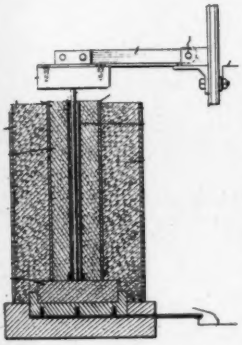
Method of Finishing Glass. U. S. 1,373,532. April 5, 1921. Lee Showers, of Charleroi, Pennsylvania, assignor to Pittsburgh Plate Glass Company, of Pittsburgh, Pennsylvania.

The invention relates to an improved method of producing a finish upon glass. It is particularly designed for use upon the white opaque glass known as Carrara glass, but it will be understood that the invention is not limited to use with such glass. The primary object of the invention is the production of a soft satin finish lacking the luster of polished glass and at the same time of such a character that it will not readily

take a pencil mark or stain and may be easily cleaned.

This invention consists in utilizing the burning action to secure the desired finish upon Carrara or other smoothed glass upon which a satin finish is desired, but without any discoloration of the glass. In carrying out the invention polishing felts which are substantially dry are employed, only enough water being employed to keep the glass reasonably cool. Upon these felts putty powder mixed with water to substantially the consistency of paint is also used. The action is similar to the "burning" heretofore referred to but no discoloration of the glass occurs, since any putty powder which is incorporated into the surface of the glass in the burning action has substantially the color (white) as the Carrara glass. The finish thus produced is soft and pleasing to the eye. It lacks the objectionable reflecting characteristic of the ordinary plate glass polish and at the same time is of such smoothness that it will not easily stain or take a pencil mark and may be easily cleaned.

Process for Making Articles of Quartz Glass. U. S. 1,375,657. April 19, 1921. John Scharl, of New York, N. Y., assignor to General Ceramics Company, of Jersey City, New Jersey, a corporation of New Jersey.

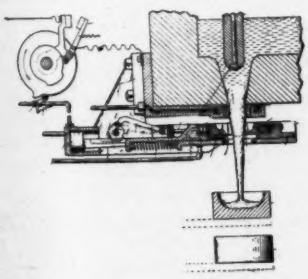


This invention relates to processes of producing articles of quartz glass and is directed particularly to improvements in the well-known process of reducing the quartz to plasticity in an electric resistance furnace with a resistance core and then blowing the plastic mass into molds.

This process requires very rapid handling of the plastic material and difficulty has been experienced in that the plastic cylinder of quartz formed in the furnace cools in being removed from the furnace to the mold and in the process of blowing the same out to the desired shape.

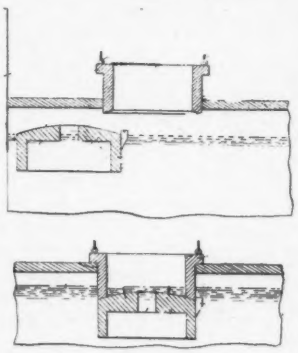
Glass-Working Machine. U. S. 1,375,336. April 19, 1921. Frank L. O. Wadsworth, of Pittsburgh, Pennsylvania, assignor to Ball Brothers, Glass Manufacturing Company, of Muncie, Indiana, a corporation of Indiana.

This invention relates in general to means for automatically charging a series of mold receptacles with molten vitreous material which is delivered thereto in a stream that flows directly from a tank or other large source of supply; and it relates particularly to the severing and manipulation of the flowing stream in such manner that the viscosity and surface tension of the vitreous material is utilized in temporarily arresting the flow of the metal at predetermined intervals for periods sufficiently long to permit of the removal of a full mold and the bringing of an empty mold to the charging position.



The primary objects of the improvements in this art are: The avoidance of surface chilling of the glass, which results from the support of any part of the hot stream of material—during either its periods of flow or its periods of arrest—on metal surfaces; the elimination of "laps" and entrained air or gas bubbles and "blisters" which are produced whenever the glass is allowed to pile up on a cutting knife or other surface intermediate between the delivery orifice and the receiving receptacle; and the maintenance of the main body of the flowing metal at all times at a uniform minimum working temperature.

Glass-Drawing Apparatus. U. S. 1,372,044. March 22, 1921. John R. Scohy, of Okmulgee, Oklahoma.

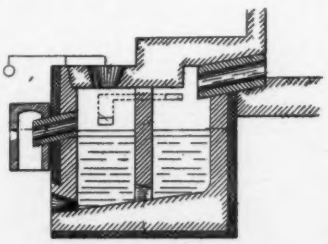


This invention relates to improvements in glass drawing apparatus, and more particularly for drawing cylinders of glass, either hollow or solid, and the invention comprehends an improvement in the above type of apparatus whereby the molten glass is kept at a uniform substantially furnace heat during drawing.

More specifically, the invention comprises an improved novel inverted pot which is made of fireclay or other refractory substances so as to float on molten glass and movable on the molten glass in the furnace so as to secure a large supply of good, clear glass and so constructed as to facilitate the drawing thereof and cause automatic cleaning or discharge of excess molten glass back into the furnace.

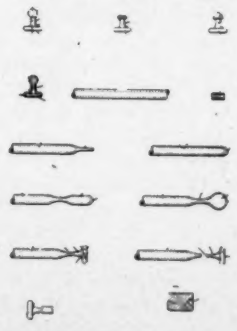
Front Discharge Chamber of Melting Furnaces. U. S. 1,361,754. Paul Dhé, Paris, France.

The invention described herein has for its object a front discharge chamber applicable to melting furnaces generally serving for the melting of materials such as glass, volcanic rock, and fusible clay.



As shown in the accompanying illustration, the discharge chamber is divided into two compartments, which are connected together at their lower part. The first compartment receives the melted material issuing from the melting furnace and thus allows it to be freed from impurities and gas bubbles which it may contain, while the second compartment received the decanted materials.

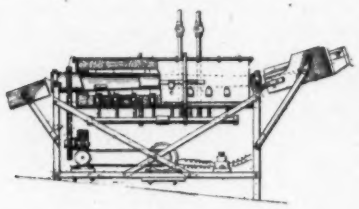
Making Glass Collar Buttons. U. S. 1,372,294. March 22, 1921. Michael Karabin, John Skociokh, and Karl Mandl, of New Britain, Connecticut.



This invention relates to improvements in making glass collar buttons, and the object of our improvement is to produce a collar button that is attractive and sanitary and by means that are simple and efficient.

Being made of two pieces, one for the body and the other for the head, the structure may be made up of two different colors for these parts. Generally plain glass would be used for the body. In the case of the head, however, a choice of colors is desirable, and is readily provided by using for the pellet the color desired.

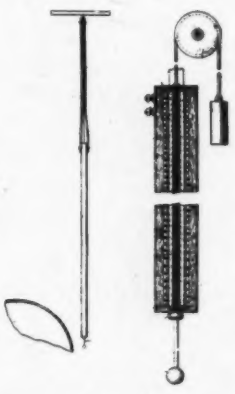
Apparatus for Heat Treatment of Articles. U. S. 1,372,420. March 22, 1921. David E. Gray, of Corning, New York, assignor to Corning Glass Works, of Corning, New York.



This invention, as shown in illustration, has for its purpose to provide a novel apparatus for feeding articles during the heat treatment thereof, to the end that all parts of the surface of such articles shall be uniformly exposed during the period in question.

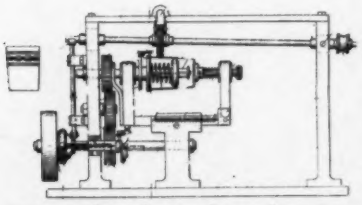
This invention comprises the use of a conoidal chamber, rotating about the conoidal axis, and means for controlling the temperature in the interior thereof, preferably, but not necessarily, by conduction through the walls of the chamber. If articles which are circular or substantially circular in cross-section, are fed into one end of such a chamber, gravity will tend in the rotation thereof to cause them to rest on and remain in the bottom thereof, and in this tendency will cause a rotary motion to be imparted thereto, whereby they will roll on the inner wall of such chamber, the articles tending to assume a position at an angle to the plane in which the articles are rotated by the chamber.

Device for Severing Glass. U. S. 1,373,728. April 5, 1921. Harry F. Hitner, of Wilkinsburg, Pennsylvania, assignor to Pittsburgh Plate Glass Company.



The invention relates to devices for severing or cracking glass by the application of heat along the desired line of division. The device is designed primarily for cutting or capping glass cylinders, but is not limited to use in such connection. The invention has for its objects the provision of an improved device: (1) which can be cheaply constructed; (2) which can be operated at small expense; (3) which is very durable as compared with the devices now employed, using a relatively small wire heated by the passage of an electric current; and (4) which can be rapidly and conveniently handled by the operator.

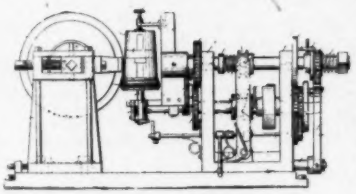
Glass-Grinding Machine. U. S. 1,372,553. March 22, 1921. Edward A. Ryon and Anna T. Ryon, of Pittsburgh, Pennsylvania, assignors to Quality Glass Company, of Pittsburgh, Pennsylvania.



The invention consists of an improvement in glass-grinding machines for engraving tumblers or similar cylindrical glass articles, and has for its object to provide means for quickly and cheaply ornamenting the surface of such articles by direct application of a grinding or cutting wheel or wheels.

The improvement consists generally in providing a rotatable holder for the ware having means for placing on and removing the ware therefrom, also means for shifting the ware longitudinally when it is desired to engrave other than continuously annular lines, cam mechanism for effecting alternating back and forth longitudinal movement to the ware holder and ware, one or more engraving wheels, and a rotating driven shaft therefor, with means providing for automatic adjustment of the wheels, automatic mechanism for terminating the operation, and other features of construction and advantage.

Glass-Grinding Machine. U. S. 1,373,836. April 5, 1921. Edward A. Ryon, of Wellsboro, Pennsylvania, assignor to Fred W. Siemens.



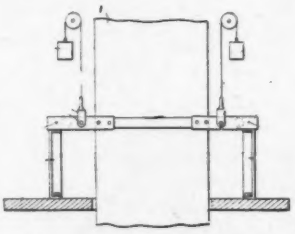
The invention relates to the decorating of glass articles by cutting or grinding designs therein, and has special reference to automatic machines for completely decorating articles of simple shape such as glass tumblers, for example.

One object of my invention is to provide a machine of the character above indicated that shall be particularly compact in construction and reliable and effective in operation.

Also to provide an improved gearing for producing an oscillatory movement of the spindle of the machine without preventing or retarding the forward and back motion of the spindle in an axial direction.

Still another object is to provide a simple and positive gearing for producing a rotative adjustment of the work.

Process and Apparatus for Severing Sheet-Glass. U. S. 1,373,533. April 5, 1921. Harry G. Slingluff, of Mount Vernon, Ohio, assignor to Pittsburgh Plate Glass Company.



The invention relates to a process and apparatus for severing a continuously formed sheet of glass. It has for its principal objects the provision of an improved severing means which will completely heat the glass on a line extending from one side of the sheet to the other without interruption; the provision of an improved device of the character specified in which arrangement is made for the movement of the device with the sheet of glass. Also a device which can be conveniently and rapidly operated and which will insure the ready severance of the sheet along the desired line, even though the sheet is not perfectly flat and even though a condition of strain exists in the glass which would otherwise prevent its proper cutting off by the use of the usual severing means such as a diamond or cutting wheel.

British Patent No. 140,304, July 9, 1920, K. Warga, covers a method of producing colored designs on glass. The designs are formed of fusible mineral glass built up in successive layers on transfer paper. The designs are transferred to the surface of the glass and fired at gradually increasing temperatures until completely fused on. The layers of materials melt at successive temperatures. The layer next to the glass melts first and the outer one last. The temperature at which the last layer melts is about 100 degrees lower than the melting point of the glass.

Glass Factory Equipment and Supplies

THE GLASS INDUSTRY will be glad to publish descriptions of new and useful devices, machinery and supplies of interest to the glass manufacturing trade. Most of the information printed in this department comes direct from the manufacturers of the products described.

Water Cooling Tanks and Furnaces

By A. H. GOODMAN*

Tanks constructed of clay blocks and with no auxiliary cooling equipment will not give standard operations. It is not uncommon for a tank to operate through a period of fifteen to eighteen months, and on the next period, nine months, then again twelve months.

The application of properly designed and constructed water coolers to continuous glass tanks and plate glass pot furnaces will initiate a new era in the glass industry as it has in the steel and other industries. It puts emphasis upon a high average of performance by maintaining standard operation and efficiency, with lower operating, maintenance and rebuilding costs; the initial cost is justified by the insurance alone. Standardization of operations has been the result in other types of high temperature furnaces such as open hearth steel, iron blast, forge, copper and electric furnaces. Standardization of operations can only be obtained by the equalization of life of the refractories in the various parts of the tank or furnace.

Water cooling of high temperature furnaces had its inception with the iron blast furnaces twenty years ago. Blast furnaces of 250 tons capacity were considered large. At that time the length of the operating period was variable and the refractories, not being water cooled, were a constant source of trouble and expense. At present practically all blast furnaces in the metallurgical industries are water cooled. Water cooling made it possible to increase length of operation, size of furnaces, production, and life of refractories. At the present time there are blast furnaces of 550 tons capacity in operation, which, in proportion, melt more iron in less time. Water cooling assisted materially in reducing rebuilding and repair costs and making possible this increased capacity and production.

Water cooling has been applied to open hearth steel furnaces for the past fifteen years. It is now general practice to install some form of water cooling device to increase the life of refractories at the various parts.

The first water cooled devices were manufactured of steel and iron castings, then copper and copper-bronze castings—none of which proved really successful. Castings must necessarily be made with thick walls, which cause them to burn through, crack and warp.

About twelve years ago, steel plate coolers of the riveted type were installed. Although not entirely successful, these installations proved that rolled steel plate was the proper material for construction. Due to the continuous expansion and contraction stresses, the rivets and caulking became loose, causing the coolers to leak. Later, steel plate coolers of pressed and welded construction were installed, and proved successful.

At present, the pressed and welded coolers have reached such a state of development that successful installations have been effected on open hearth steel, soaking pits, forge and reheating furnaces, electric steel, copper refining and blast furnaces, puddling and malleable iron furnaces, sheet and tin mills and glass tanks manufacturing all kinds of ware, silicate of soda and other chemical furnaces.

Practically every glass manufacturer has attempted water cooling the blocks in some form or other. Some have used steam blast, others water over the outside of the blocks; others have put a plate next to the blocks, over which the water flowed—all of which methods are decidedly crude.

There are a few factories which operate air cooling systems until the blocks become thin and show red, at which time they apply water coolers to assist them in maintaining operations. Were air cooling to be continued, the glass would break through in a week or so. The water coolers, however, assist them in operating months longer. This is continued until a great portion of the tank is water cooled. It is evident that if water cooling will maintain operation under such severe conditions, it will do even better if installed at the beginning of operations, when the blocks are eight inches or more in thickness.

When molten glass is to be chilled, pouring water on it will cause it to solidify much quicker than blowing air on it. But water could not very well be poured on a hot block for any length of time and persistently, for even though it would cool the block, it would also cause disintegration. However, with steel plate water coolers it is possible to get this cooling effect without the disintegration. Raw water is used for cooling, but a plate is interposed to act as a conductor between the blocks and the water and thus protect the blocks. The water gives the benefit in both cases, yet in the latter the objections are eliminated.

Circulating air dissipates the heat around the tank blocks, merely displacing it. It can at most cool the surface of the blocks. Air does not have the ability to penetrate into the block to any great degree, nor prevent the glass from breaking through should the blocks become thin.

Spalling tests made of refractories, comparing cooling by air blast with cooling by dipping the hot brick in cold running water showed that the cracking or disrupting effect of water was about ten times as severe as that of air, which would lead naturally to the conclusion that water cooling is much more effective than air cooling. Consideration should be given, of course, to the method of application.

Rolled steel plate is known to be the best material for construction of coolers. It has all the qualities of strength, ductility, and conductivity, to make it especially applicable to water cooling. Steel plate has the ability to withstand fluctuations in temperature and the action of slag and oxides and can be pressed and welded into any shape desired. When subject to severe stresses, it can be readily reinforced with stay bolts and corrugations. Steel plates admit of complete and ready inspection. Due to the conductivity of steel the water in the coolers keeps the outside surface of the plate at practically the same temperature as the inside surface.

A tank or furnace is designed and constructed to give the greatest efficiency. After a period of operation any deviation from the original lines causes variation in efficiency, production and fuel consumption. The object of proper water cooling is to maintain the original lines of the tank and prevent variation in the action of the refractory linings—in short to effect standardization of operation and life of refractories.

In contact with refractories, which are very poor conductors of heat, the cooling effect of the water penetrates into the block, at most, about six inches, and is usually effective in keeping the refractories from softening because of the heat for about 4 to 4½ inches.

Coolers of the Knox type may be installed on throat type, bridgewall type and floater type tanks, at the side blocks, filling-in end, doghouse, bridgewall, throat, arch over the doghouse, port tongue, port sides, port skewback, shields, etc. All the equipment noted would not in any case be necessary on one tank but the items are mentioned as suggestions for particular conditions.

*Sales Engineer, Blaw-Knox Company, Pittsburgh, Pa.

On floater type or window glass tanks, coolers are placed at the side blocks, filling-in end, doghouse, neck, port tongue, port sides, port skewback, water-cooled doors and frames at the lading openings, arch over the doghouse, etc. The coolers are manufactured of pressed and welded ⅜-in. rolled steel plate, stay-bolted and corrugated to withstand considerable physical abuse. They are placed directly against the outside of block and are held in place by jack bolts, just as any block. As the block wears down to the slightly chilled surface, a thin insulation of gummy glass forms, acting as a protection to the blocks from the various actions of the melt.

The doghouse coolers protect this weak part of the tank and strengthen the doghouse to equal the remainder of the tank. If these blocks, for any reason, fall or wear away from the cooler, the cooler will prevent the glass from breaking through and operations may be continued even with the glass in direct contact with the cooler.

The throat cooler forms a saddle covering three sides of the throat and prevents the throat blocks from wearing away, equalizing the life of this weak part of the tank to that of the remainder. The coolers prevent the throat from widening out or becoming too large, thereby preventing too much glass from going through as is the case with the average air cooled throat.

The bridgewall cooler extends up to the under side of the cover block at the bridgewall and lengthens the life and protects the side block of the bridgewall from wearing away and the glass from breaking through.

A water-cooled port takes in coolers at the port tongue, the side jambs and the skewbacks. The port tongue cooler acts as a buffer against the outgoing gases and eliminates the wearing back and falling down of the division arch between the air and gas ports. When using the dry tongue, the outgoing gases tend to wear it back, the point of combustion likewise falling back until it comes to such a state that the tongue tile falls down.

The skewback cooler is placed at the neck where the main roof connects with the roof of the port. The skewback cooler supports the crown and is bolted to the buckstays. The invert arch and the arch over the port opening are eliminated.

The port jamb coolers are placed at the junction of the side walls of the ports and the main side walls of the tank, 4½ inches from each side.

In the past there has not been sufficient attention given to the construction and design of ports. Proper fuel economy depends materially on good design at the port. A water cooled port makes possible the placing and holding of the port at the point best for combustion, and holds the port to the proper size throughout the entire run of the tank, or furnace.

For plate glass pot furnaces there are water-cooled tuilles (doors), pillar stones (jambs), the arches over the charging opening (skewback) and at the port and gas uptakes. The coolers at the door or charging opening are termed three-piece frames and surround the opening, keeping the pillar stones from burning away. The crown is supported by the skewback. Thus when the furnace man finds it necessary to rebuild the pillar stones, he can do so without the destruction of the roof. The tuilles, or doors, slide up and down on the frame and are easily installed and operated. They are always brick-lined on the inside and act as a shield, keeping the heat from the operators, thus increasing their efficiency. The brick insulation in the door prevents any chilling of the furnace. The door can easily be removed and relined off the furnace.

To give an idea of the efficiency that has been attained by operating furnaces with pressed and welded steel plate coolers: An air-cooled throat in a bottle tank had an operating period of only nine months. A throat cooler was installed and the tank operated for twenty-six months without repairs. The throat at one time was the weakest part of the tank, but now is the strongest.

Another tank making chimneys operated for an average of four or five months without coolers. Coolers were installed practically all around the tank; the tank was operated for twelve months without repairs. At the end of the fire the blocks adjacent to the coolers were about 5 inches thick. Had not a portion of the tank not water-cooled broken through suddenly, as far as the coolers were concerned longer operations would have been possible.

A company installed a throat cooler at a throat block which was in very bad condition; in fact, the glass was practically oozing through the blocks. This cooler assisted the tank in operating nine months longer without repairs. The tank with the exception of the throat was repaired and is still operating. Another company installed two sets of throat coolers on two of their tanks. The object of one being to increase the life of throat blocks and the object of the other was to maintain the proportion of the flow hole through the throat in order to maintain the quality. Both objectives were realized.

Window glass tanks using salt cake in the batch entirely were water-cooled and operated throughout a period of 22 weeks with absolutely no hot settings or repairs. Previous to the installation of the coolers, ordinarily two to four hot settings were necessary. On some parts of the tank at the end of the fire the coolers were quite void of any covering. A thorough inspection of the coolers proved them to be in excellent condition; neither the salt cake, abrasive action, nor the heat had any effect whatsoever on the steel. The managers of these companies stated that were it not for business conditions there was no doubt but what they could have operated for months longer, even with the tanks in this condition.

A wire glass floater-type tank operated with steel plate water coolers all around the tank for 4½ years and on the last five operated continuously for over two years without any repairs or hot settings. The tank operated during the last eight or nine months with 60 per cent of the blocks worn away. Previous to the installation of coolers the tank had an average length of operation of nine months.

It is occasionally the assumption that a tank operated with water coolers consumes more fuel. This is absolutely contrary to the writer's experiences with any type of high temperature furnace. Fuel consumption data has been kept, covering a number of furnaces operating with water coolers completely around the tank and in no case has any noticeable increase been found.

Manufacturers interested in water cooling their tanks are vitally interested in the water consumption. The amount of water necessary is variable, depending materially upon the size of the different coolers, the condition of the furnace, and also the quality of water. The coolers at the end of a fire will require more water than at the beginning, when the walls are comparatively thick. When water contains lime or other solids that precipitate when the water is heated, the precipitating temperature should be determined in a laboratory and the outlet water be kept 10 or 15 degrees F. below this temperature. This may require more water, but insures longer life of the cooler and less trouble. Used water need not be wasted but may be utilized over again in boilers, producers, etc.

It should be emphatically understood that water coolers, to give efficient results, must be properly designed and constructed. Each installation is a study in itself. Water cooling is a science and art that cannot be undertaken promiscuously. It requires considerable study and experience and a full understanding of the fundamental principles of design and manufacture and application.

Mammoth Feeder Installation

The largest automatic feeder built by the Miller Glass Engineering Company, Swissvale, Pa., is now being installed at the plant of the Jeannette Glass Company, Jeannette, Pa. This feeder, which has been in the course of development for the past 14 months, is especially designed for making extra large sized pressed, and pressed and blown ware, such as mixing bowls, fish globes, battery jars and kindred article. It is adaptable for dropping compact gobs of glass weighing up to 250 ounces directly into a mold without the aid of a chute at a speed up to 25 per minute.

Annual Meeting A. S. T. M.

The twenty-fourth annual meeting of the American Society for Testing Materials will be held at the New Monterey Hotel, Asbury Park, N. J., from June 20 to 24 inclusive. In about a month a provisional program including announcement of entertainment features will be sent to the members.

To Provide "Science Service"

With the object of acquainting the general public with the importance of and progress in scientific research, the National Research Council has established and endowed a "Science Service" through which accurate and interesting facts pertaining to all branches of science and technology will be made available at the lowest possible cost. Distribution of scientific information will be made through newspapers, periodicals, books, conferences, lectures, motion pictures and other educational media. Existing news agencies and news service associations will be utilized whenever possible.

Cost Accountants Annual Convention

The preliminary program of the annual convention of the National Association of Cost Accountants which is to be held in Cleveland on September 14, 15 and 16 next, has just been issued. It provides for three days of conferences on practical cost questions including "Interest as an Element of Cost," "Cost Systems as a Means of Preventing Waste," "Uniform Methods and Standardized Costs," "Executive Use of a Cost System," and a number of similar topics. It is expected that upwards of one thousand cost men will take part in these conferences.

To Attack Problems of Waste

The American Engineering Council of the Federated American Engineering Societies recently announced the appointment of a committee on the elimination of waste in industry, and issued the following statement: "The Federated American Engineering Societies, in which the national and local engineering societies of the nation are coalescing, is organized for public service. Unemployment, intermittent employment, strikes, lockouts and restrictions of output are waste. Disuse and misuse of machinery and equipments and losses of manufacturing materials are likewise waste. Stabilization of industry is a crying need, and also an engineering problem. Labor, capital, management and the consuming public stand to gain if common constructive action can be taken to lessen the idleness of men, idleness of productive equipment and the utilization of material."

To Discuss Handling of Materials

At the 1921 spring meeting of The American Society of Mechanical Engineers, to be held at the Congress Hotel, Chicago, Ill., May 23-26, the new Materials Handling Division of the society will discuss the design and operation of mechanical equipment for handling material. The purpose of this division, which already has nearly 1,000 members, is to make possible more efficient methods and means of handling the commodities of everyday life. A recently issued bulletin setting forth the plans of the division says:

"Material handling in this division is concerned only with what may be called the problems of secondary transportation of materials and commodities. It does not concern itself with the broad transportation problems of the common carriers, or the tributaries to common carriers, such as organized highway trucking systems, interurban freight lines, and so on.

"Material handling has to do with the multitudinous operations of 'picking up and putting down' materials in process of production, and the handling problems of the linkages between common carriers and delivery to the user."

The report sums up the spirit of the new division with this striking statement:

"The subject of Material Handling should be taken out of a rule-of-thumb basis and put on an engineering basis in all its phases."

Glass Division's Proposed Visit to England

W. M. Clark, chairman of the Glass Division of the American Ceramic Society, has issued the following bulletin relative to the invitation to visit the glass works of England, extended to the Division some time ago by Dr. W. E. S. Turner, on behalf of the Society of Glass Technology:

"The British Society of Glass Technology has invited the members of the Glass Division of the American Ceramic Society to pay a visit to England during the summer of 1922. At the Columbus meeting a committee was appointed to survey and canvass the situation among the American glass manufacturers, ascertain the probable expense, time involved, etc., and learn how many American glass men feel that there is a possibility of their making the trip. Charles O. Grafton, Gill Clay Pot Company, Muncie, Ind., is chairman of this British Trip Committee.

"This will offer the first opportunity that American glass men have had as a body to see manufacturing in Europe. No definite plans have yet been formulated, but a suggested itinerary is to spend one day at Manchester visiting glass works, etc., followed by four days in Sheffield visiting glass works, steel works and refractory materials works in South Yorkshire and neighborhood. Also to visit places of historic interest and have a joint conference with the Society of Glass Technology.

"The party will then go to Scotland, stopping at Leeds, and if desired, spend two days in the Lake District en route to Scotland. In Glasgow, one day visiting glass works, and two days around Edinburgh, Perth, etc., visiting glass works and scenes of historic interest. Newcastle-on-Tyne is the next city where one or two days will be spent visiting plants in Newcastle, Gateshead and Sunderland, followed by York, where there is a works and historic city. Birmingham and Stourbridge call for two days to see glass works and fire clay and refractory plants, after which the party will go to Stratford-on-Avon for a day, and also spend a day in Oxford. The wind-up of the trip will be London for four days to see glass plants and the various places of interest and to have a further meeting with the Society of Glass Technology.

"The total approximate time required is estimated at from 22 to 25 days. The distances are short, and total railway fares will only amount to around $30. Hotel charges are lower than in America, and run from $2 to $4 per night, including breakfast. It will thus be noted that the main expense of the British trip will be the steamship fares.

"The foregoing is merely an outline of a suggested trip which promises to be of much interest to all who can embrace the opportunity to go."

William C. Ball

WILLIAM C. BALL, secretary of the Ball Brothers Glass Manufacturing Company, Muncie, Ind., died at his home on April 30, following a week's illness of pneumonia. Mr. Ball was sixty-nine years of age.

A. C. Carp

A. C. CARP, president of the Syracuse Glass Company, Syracuse, N. Y., distributors of flat glass, died on April 20. Mr. Carp was about 60 years of age.

John A. Burt

JOHN A. BURT, who for many years represented the Maryland Glass Corporation in the New York City territory, died on April 7.

Trade News

THE SNEATH GLASS COMPANY, Hartford City, Ind., are installing Miller automatic machines and feeders, part of which are already in operation. Heretofore the Sneath plant has been entirely hand-operated.

The following officers were selected for the ensuing year at a recent meeting of the MASONTOWN GLASS COMPANY, Masontown, Pa.: President, John B. Sterling; vice-president, P. H. Ralston, and secretary-treasurer, W. L. Graham.

THE TIRRILL GAS MACHINE LIGHTING COMPANY, makers of kerosene gas producing machines for industrial purposes, announce that their offices have been moved to the Hudson Terminal Building, 50 Church street, New York.

CHARLES H. HARRIS, INC., manufacturers of automobile windshields, Norwalk, Conn., have purchased property at 112-128 Main street, on which will be erected in the immediate future a factory and office building at an estimated cost of $50,000.

THE ALTOONA PLATE GLASS AND BEVELING COMPANY, 812 Ninth street, Altoona, Pa., has been organized by George D. Hanna and George A. Makdad. The company will deal in all kinds of glass and will engage in silvering mirrors, and polishing and grinding of glass.

THE POTOMAC GLASS MANUFACTURING COMPANY, Cumberland, Md., announces that press reports to the effect that they are planning extensions and reconstruction of their plant are erroneous and that under present conditions they do not contemplate making any improvements.

THE TIDEWATER GLASS COMPANY, Wheeling, W. Va., was recently incorporated by George A. Blackford and A. Seamon, of Wheeling, and A. J. Gilleland, of Martins Ferry, O. The company, which was incorporated with a capital stock of $250,000, will manufacture glass products.

The Samuels Art Glass Company, manufacturers of art glass and mirrors and dealers in plate and window glass, San Antonio, Texas, has changed its name to the SAMUELS GLASS COMPANY. The company expects, in the near future, to start building a three-story plant on South Alamo street.

According to press reports, the plant of the THATCHER MANUFACTURING COMPANY, manufacturers of milk bottles, Dunkirk, N. Y., was destroyed by fire on April 21. The damage is estimated at $200,000. The warehouse, packing and shipping departments were totally destroyed as were 500,000 milk bottles stored in the warehouse.

THE CADILLAC GLASS COMPANY, Detroit, Mich., was recently incorporated by Fred L. Stoker, Ray L. Martin and Henry J. Berndt with a capital stock of $500,000. The company's office and warehouse are located at 2570 Hart avenue, and they will carry in stock plate and window glass, rough and ornamental glass, and mirrors.

THE BISON PLATE & WINDOW GLASS CORPORATION, 96-98 Seneca street, Buffalo, N. Y., dealers in all kinds of glass, formally opened their factory, offices and retail store at the above address on April 19, with a celebration for their employees and friends. E. J. Lienert, formerly sales manager of the Buffalo Glass Company, is manager of the new corporation.

STEIN & ATKINSON, LTD., London, England, have become associated with the Stephens-Adamson Manufacturing Company, Aurora, Ill., for the purpose of promoting sales of S-A glass plant conveyors and other machinery throughout Great Britain. Arrangements will be made within a short time to manufacture the Stephens-Adamson Company's products in Great Britain.

THE AMSLER-MORTON COMPANY, industrial engineers and constructors of glass furnaces, gas producers and other glass factory equipment, moved their office into temporary quarters at their new plant at Parkview, Pa., pending the completion of their new office building. It is expected that the new plant will be in operation in about sixty days.

A slight gain in average earnings of workers in the glass trades in New York State is reported in the statement for March issued by Henry D. Sayer, Industrial Commissioner. Compared with March, 1920, however, the average weekly earnings for March, this year, show a decrease of $3.26, one of the most conspicuous reductions among all of the trades included in the Commissioner's reports.

At the request of Herbert Hoover, Secretary of Commerce, a group of 75 business paper editors had a close conference with him in Washington, D. C., April 12. These conferences are, at his request, to be continued once a month. Mr. Hoover wants the editors to give him the benefit of their highly specialized knowledge in making the Department of Commerce of the greatest possible service to business.

The Chicago office of the UEHLING INSTRUMENT COMPANY of New York, manufacturers of fuel saving equipment, was moved May 1 to the Great Northern Building, 20 West Jackson Boulevard. Walter C. Lange, who has been appointed manager of this office, is particularly well qualified to co-operate with power plant operators in solving problems of fuel conservation because of his former experience in this field with the Consolidated Gas Company of New York and the Hammel Oil Burning Equipment Company and, until recently, in the New York office of the Uehling Instrument Company. Mr. Lange is a member of the American Society of Mechanical Engineers and a graduate in Mechanical Engineering of the Stevens Institute of Technology. Uehling CO_2 recording equipment and other boiler room instruments will be on display in the new office.

Trade Publications

Of interest to users of refractories is the Laclede-Christy Bulletin issued monthly by LACLEDE-CHRISTY, St. Louis, Mo. The April issue describes briefly the Company's manufacturing plant comprising 66 buildings, with 56 kilns having a daily capacity of 700 tons. Glasshouse refractories is one of the Company's chief products, their business in this line exceeding that done with any other industry among all that they cater to.

Libbey-Owens Opens New York Office

THE LIBERTY-OWENS SHEET GLASS COMPANY have opened a New York office at 253 Broadway—rooms 613-614-615. W. S Wilcox, eastern representative, is in charge of the sales in this district of the Company's products, manufactured by their recently perfected continuous sheet drawing process.

The New York office of the OWENS BOTTLE COMPANY has been moved to the same address.

Prompt Action Necessary to Defeat the Haugen Bill

That strong influences are behind the Haugen Bill is evident from the fact that it has been introduced, unamended, for the third time into the House of Representatives and has received the approval of the committee without public hearings.

When this bill (now known as H. R. 4981) was up in the last session of Congress, THE GLASS INDUSTRY, quoting from a pamphlet issued by the Glass Container Association, said:

"The bill is an attempt to bring under the ban of the Pure Food and Drug Act, certain types of glass containers, on the theory that they are so made, formed and shaped as to deceive or mislead the purchaser as to quantity, quality, size, kind or origin of the food therein.

"Should this bill pass the Senate and become a law it will do tremendous damage, not only to the thousands of packers and bottlers of foods, drinks and drugs in glass, and to the manufacturers of machinery and supplies for the packing industry, but also to the makers and handlers of glass containers, to the glass factory equipment and supply trade, to the manufacturers of caps, corks, cartons, shipping cases, labels and other accessories. It will cause immense losses by compelling manufacturers to throw on the junk heap hundreds of thousands of dollars' worth of molds, cartons and other supplies.

"It will tend to destroy millions of dollars' worth of good-will for those packers and bottlers who have chosen for their products distinctive glass containers in which their own individuality can be expressed.

"The glass industry stands for honest packing and full measure, but it opposes the Haugen Bill because it would be indefinite in its interpretation and administration. No manufacturer would know what kind of a bottle he could lawfully make. If the present bill be passed and become law, then no bottle manufacturer can afford to make up any particular bottle without first getting the approval of the Secretary of Agriculture. Even then he is not safe, because the Secretary of Agriculture is not always the same person and a succeeding Secretary might have an entirely different view. On the other hand, there is nothing to prevent the same department from changing its own judgment as to how the law should be interpreted, not only once but several times.

"If the Department should carry out what seems to be the full intent of this Act it would prohibit the manufacture of every style or kind of bottle except a round one, with the very shortest possible neck, because every bottle that departs, even in a small way, from plain round would have in it qualities that could be said to make it 'likely to deceive or mislead,' and if this were followed out, all standards of design and artistic arrangement intended to make the package attractive would be reduced to the lowest level of the commonplace.

"The law would be dangerous because it would place arbitrary power in the hands of department inspectors and present opportunities for dishonest practices. In discussing the measure before the House, Congressman Mann said in part: 'I do not want to leave it to a department clerk or a clerk in the office of the solicitor of the Agricultural Department to say as between two men on his new inspection, "I think you are violating the law and should go to the penitentiary," when no one can tell in advance how he is going to obey the law.'

"The bill says, 'or if it be in a container so made, formed or shaped, as *likely* to deceive or mislead the purchaser, etc.'

"Does it not seem ridiculous to think that a transparent glass bottle, with the exact quantity of the contents plainly printed on the label, could be 'likely to deceive or mislead'? The passage of this bill will assume that the public has a lower standard of intelligence than is generally accredited to it."

The time has again arrived for all who have the interests of the glass container industry at heart to make their influence felt by immediately telegraphing or writing briefly to their senators and representatives, urging that glass containers be specifically exempted from the provisions of the bill H. R. 4981.

Glass Container Manufacturers Meet

Meetings of the National Bottle Manufacturers Association, the Glass Container Association and the National Glass Container Traffic Association were held at the Marlborough-Blenheim Hotel, Atlantic City, on April 28, 29 and 30.

On Thursday and Saturday the bottle manufacturers gathered together, listened to the report of Geo. S. Bacon, chairman of the managing committee and discussed market statistics and conditions, wages, costs, and the outlook for the future.

Officers of the National Bottle Manufacturers' Association were elected as follows: G. W. Yost, president; George S. Bacon, vice-president; W. B. Gundling, secretary-treasurer.

At the Glass Container meeting on Friday, the 29th, the principal interest centered in the discussion of the proposed advertising campaign planned for the purpose of increasing the popularity and use of glass containers and products packed in glass containers. Addresses were made by Dr. A. W. Bitting, Judge I. G. Jennings and C. C. Parlin of the *Saturday Evening Post*.

Of the five directors of the Association whose terms were expiring, George W. Yost, E. B. Ball, J. M. Beatty and H. J. Booth were re-elected and F. E. Baldwin was elected to take the place of J. M. Woodward, retiring.

Much regret was expressed over the absence of the president, J. D. Biggers, who is convalescing from an attack of typhoid fever.

Plans were put before the meeting for a co-operative advertising campaign along the lines described in a recent issue of THE GLASS INDUSTRY*, the campaign to have the backing and financial support of the packers of food and other products in glass, the manufacturers of containers, and all of the supply trades catering to these industries. The plans met with hearty approval, a particularly interesting feature being the enthusiasm displayed by the smaller manufacturers. Within a short time the advertising campaign will unquestionably become a reality.

The Glass Container Association has issued from their office, 70 Fifth Avenue, New York, a 28-page pamphlet setting forth completely the "Plan, Agreement and Reasons for Advertising Glass Containers."

*January, 1921, pp. 18-19.

1919 Census of the Glass Industry

The first statement issued by the Bureau of Census, a preliminary summary of the results of the 1919 census of the glass industry, prepared by Eugene F. Hartley, Chief Statistician for Manufacturers, has been issued. A comparison of the production figures for the years 1919 and 1914, show that while the quantity of window glass produced in 1919 was less than in 1914, the value was almost two and one-half times as great. Decreased production of plate glass is shown, together with an increase of more than 100 per cent. in the total value. The value of pressed and blown products, bottles, jars, etc., also shows a large increase. A decrease of 23 in the number of factories making building glass has taken place, while there has been an increase from 107 to 130 in the number of factories making pressed and blown glass. There were 11 less plants producing bottles, jars, etc., in 1919 than in 1914.

COMPARATIVE SUMMARY OF STATISTICS FOR THE GLASS INDUSTRY, 1919 AND 1914.

	Number of Establishments		Production	
	1919	1914	1919	1914
Total for the industry.....	367	348	$254,709,000	$123,085,000
Building glass.....	125	102	$83,718,000	$36,824,000

Window glass:				
Quantity.....square feet	...	...	368,912,209	400,998,893
Value	...	...	$41,106,000	$17,496,000
Obscured glass, including cathedral and skylight:				
Quantity.....square feet	...	...	33,822,302	43,040,079
Value	...	...	$4,300,000	$2,417,000
Plate glass (made for sale):				
Quantity.....square feet	...	...	57,612,491	60,515,008
Value	...	...	$33,519,000	$14,800,000
Wire glass:				
Quantity.....square feet	...	...	15,691,486	15,688,844
Value	...	...	$2,907,000	$1,591,000
All other building glass:				
Value	...	...	$1,886,000	$520,000
Pressed and blown glass—value	130	107	$70,708,000	$30,279,000
Bottles, jars, etc.—value	139	150	$87,762,000	$51,959,000
All other products—value	...	...	$12,521,000	$4,023,000

In 1919, 102 establishments were located in Pennsylvania, 77 in West Virginia, 43 in Ohio, 35 in Indiana, 21 in New Jersey, 19 in New York, 16 in Oklahoma, 12 in Illinois, 8 in Maryland, 7 in California, 5 in Kansas, 4 in Missouri, 3 each in Arkansas and Virginia, 2 each in Louisiana, Texas and Wisconsin, and 1 each in Massachusetts, Michigan, Rhode Island, South Carolina, Tennessee and Washington.

Foreign Trade Opportunities

Recent issues of the Daily Consular and Trade Reports issued by the Bureau of Foreign and Domestic Commerce, Washington, D. C., list the following items. Further information concerning any of them may be obtained from the Bureau or its district offices by duly registered firms and individuals, by written request giving opportunity number.

Registration in the Importers' Index entitles the registered firm to receive further information concerning items listed in the Daily Commerce Reports. Registration may be obtained by making application to the Bureau of Foreign and Domestic Commerce, Washington, D. C., or to one of the district or cooperative offices located in nearly all of the large cities, and by filling out "form 57." Registered firms receive additional circulars and bulletins of various sorts relating to their particular line of business.

34770.—A manufacturer in India desires to purchase and secure an agency for the sale of glass bottles. Quotations should be given c.i.f. Bombay or Karachi. References.

34,776.—A manufacturers' representative in Mexico desires to secure an agency for the sale of bottles. References.

34,717.—A manufacturing company in India desires to purchase from a manufacturer white glass bottles for containing hair oils, baby foods, etc. Quotations should be given c.i.f. Indian port. No reference offered.

34,720.—A retail drug merchant in Canada desires to purchase druggists' glassware. Quotations should be given f.o.b. port of shipment. References.

Inquiries Received

Further particulars may be obtained from THE GLASS INDUSTRY

No. 19.—Kindly send us a list of manufacturers of perfumery bottles and of glass linings for salve boxes.

No. 20.—We are going to erect a factory in a few months when building conditions are better and then will be in the market for a new outfit for silvering mirrors, also for the latest types of beveling machinery.

No. 21.—I would be pleased to receive a sample copy of your journal as I expect to be in the market for some raw materials.

No. 22.—Will you kindly put us in touch with bottle manufacturers who would be willing to co-operate with us to make tests of glass containers for carrying a product now shipped abroad in tin cans.

No. 23.—Kindly give us the names of manufacturers of cadmium sulphide yellow.

Imports of Glass and Glassware During 1920

Including Entries for Immediate Consumption and Withdrawals from Warehouse for Consumption.

	Unit of quantity.	Rates of duty.	Quantities.	Values.	Duties.	Equivalent ad valorem.
GLASS AND GLASSWARE:						
Bottles, vials, demijohns, carboys, and jars, plain green or colored, molded or pressed, and flint, lime, or lead, n. s. p. f., ordinarily used as containers—						
Bottles, vials, and jars—				Dollars.	Dollars.	Per Cent.
Empty	Pound	30%	1,278,576	75,684	22,705.20	....
Do. (reciprocity treaty with Cuba)	Pound	30%-20%	46	11	2.64	24.00
Filled	Pound	30%	2,446,654	122,331	36,699.30	....
Do. (from Virgin Islands)	Pound	Free	100	5	.....	....
Containing mineral waters	Pound	10%	1,898,724	56,862	5,686.20	....
Do. (reciprocity treaty with Cuba)	Pound	10%-20%	20	1	.08	8.00
Demijohns and carboys (covered or uncovered)—						
Empty	Pound	30%	218	53	15.90	....
Filled	Pound	30%	136,145	6,695	2,008.50	....
Containing mineral waters	Pound	10%	175,271	6,900	690.00	....
Glassware, blown, either in a mold or otherwise, n. s. p. f.—						
Bottles and bottle glassware	Pound	45%	124,917	25,010	11,254.50	....
Bulbs for incandescent lamps and tubes for making them		45%	....	1,045	470.25	....
Chemical glassware, including flasks and beakers; graduated ware, as burettes and pipettes; glass tubing; lamp-blown and volumetric ware made from glass tubing; reagent bottles, and all ware known as chemical ware.		45%	....	190,624	85,780.80	....
Chimneys for oil lamps	Number	45%	21,806	863	388.35	....
Chimneys for glass lamps and tubing for same	Number	45%	133,964	5,081	2,286.45	....
Globes and shades for gas and electric lights	Number	45%	34,408	1,886	848.70	....
Tableware and bar glass		45%	....	38,347	17,256.15	....
All other articles		45%	....	926,235	416,805.75	....
Glassware, molded or pressed—						
Candlesticks, candelabra, and chandeliers, and parts of, and other articles that can be used in connection with artificial methods of illumination, n. s. p. f.		30%	....	1,634	490.20	....
Globes and shades for gas and electric lights	Number	30%	37	23	6.90	....
Tableware and bar glass		30%	....	7,151	2,145.30	....
Glassware of every description, composed, etc., of glass, ornamented or decorated in any manner, or cut, engraved, painted, decorated, ornamented, colored, stained, silvered, gilded, etched, sand-blasted, frosted, or printed in any manner, or ground (except such grinding as is necessary for fitting stoppers or for purposes other than ornamentation), n. s. p. f.						
Bottles and decanters	Number	45%	2,473,937	226,834	102,075.30	....
Candlesticks, candelabra, chandeliers, and parts of, and other articles that can be used in connection with artificial methods of illumination, n. s. p. f.		45%	....	41,631	18,733.95	....
Globes and shades for gas and electric lights	Number	45%	12,476	2,173	977.85	....
Tableware and bar glass		45%	....	112,575	50,658.75	....
All other articles		45%	....	761,996	342,898.20	....
Do. (reciprocity treaty with Cuba)		45%-20%	....	3	1.08	36.00
Optical instruments, including lenses and spectacles—						
Lenses of glass or pebble, molded or pressed, or ground and polished to a spherical, cylindrical, or prismatic form, and ground and polished piano or coquill glasses wholly or partly manufactured.		25%	....	71,426	17,856.50	....

	Unit of quantity.	Rates of duty.	Quantities.	Values. Dollars.	Duties. Dollars.	Equivalent ad valorem. Per Cent.
Opera and field glasses, optical instruments, and frames and mountings for the same	.....	35%	....	523,141	183,099.35	....
Spectacles, eyeglasses, and goggles, and frames for the same, or parts thereof, finished or unfinished	Dozen	35%	8,625	20,508	7,177.80	....
Surveying instruments, telescopes, microscopes, photographic and projecting lenses, and frames and mountings for the same	.....	25%	....	284,420	71,105.00	....
Do. (from Philippine Islands)	.....	Free	....	75	....	....
Plates or disks, rough-cut or unwrought, for use in the manufacture of optical instruments, spectacles, and eyeglasses, and suitable only for such use	Pound	Free	941,860	980,289	....	....
Sheet and plate glass—						
Cylinder, crown, and common window glass, unpolished—						
Not exceeding 150 square inches	Pound	⅞c lb.	3,190,492	319,395	27,916.81	8.74
Above 150 and not exceeding 384 square inches	Pound	1c lb.	1,166,053	101,795	11,660.53	11.45
Above 384 and not exceeding 720 square inches	Pound	1⅛c lb.	499,044	48,158	5,614.25	11.66
Above 720 and not exceeding 1,200 square inches	Pound	1½c lb.	303,369	27,442	4,550.54	16.58
Above 1,200 and not exceeding 2,400 square inches	Pound	1⅞c lb.	144,035	15,768	2,700.65	17.13
Above 2,400 square inches	Pound	2c lb.	16,037	1,021	320.74	31.41
Bent, ground, obscured, frosted, sanded, enameled, beveled, embossed, engraved, flashed, stained, colored, painted, ornamented, or decorated—						
Not exceeding 150 square inches	Pound	⅞c lb.+4%	122,731	19,445	1,851.70	9.52
Above 150 and not exceeding 384 square inches	Pound	1c lb.+4%	79,069	11,959	1,269.05	10.61
Above 384 and not exceeding 720 square inches	Pound	1⅛c lb.+4%	207,218	16,271	2,982.04	18.33
Above 720 and not exceeding 1,200 square inches	Pound	1½c lb.+4%	84,574	8,111	1,593.05	19.64
Above 1,200 and not exceeding 2,400 square inches	Pound	1⅞c lb.+4%	249,583	32,242	5,969.36	18.51
Above 2,400 square inches	Pound	2c lb.+4%	4,771	685	122.82	17.93
Cylinder and crown glass, unpolished, silvered—						
Above 150 and not exceeding 384 square inches	Pound ..... / Sq. foot	1c lb. ..... / 1c. sq. ft.	753 / 736	144	14.89	10.28
Above 384 and not exceeding 720 square inches	Pound ..... / Sq. foot	1¼c lb. ..... / 1c sq. ft.	624 / 600	88	13.02	14.80
Above 720 and not exceeding 1,200 square inches	Pound ..... / Sq. foot	1½c lb. ..... / 1c sq. ft.	1,100 / 1,000	480	26.50	5.52
Bent, ground, obscured, frosted, sanded, enameled, beveled, etched, embossed, engraved, flashed, stained, colored, painted, ornamented, or decorated—						
Above 150 and not exceeding 384 square inches	Pound ..... / Sq. foot	1c lb.+4% ..... / 1c sq. ft.	2,750 / 800	248	45.42	18.31
Above 384 and not exceeding 720 square inches	Pound ..... / Sq. foot	1¼c lb.+4% ..... / 1c sq. ft.	8 / 3	39	1.68	4.31
Cylinder and crown glass, polished—						
Not exceeding 384 square inches	Sq. foot	3c sq. ft.	12,327	7,877	369.81	4.69
Above 384 and not exceeding 720 square inches	Sq. foot	4c sq. ft.	30,904	22,075	1,236.16	5.60
Above 720 and not exceeding 1,440 square inches	Sq. foot	7c sq. ft.	16,686	18,553	1,168.02	6.30
Above 1,440 square inches	Sq. foot	10c sq. ft.	6,337	5,387	633.70	11.76
Bent, ground, obscured, frosted, sanded, enameled, beveled, etched, embossed, engraved, flashed, stained, colored, painted, ornamented, or decorated—						
Not exceeding 384 square inches	Sq. foot	3c sq. ft.+4%	150	26	5.54	21.31
Above 384 and not exceeding 720 square inches	Sq. foot	4c sq. ft.+4%	2,961	3,496	258.28	7.39
Silvered—						
Not exceeding 384 square inches	Sq. foot	4c sq. ft.	10,173	4,769	406.92	8.53
Above 384 and not exceeding 720 square inches	Sq. foot	5c sq. ft.	22,828	16,092	1,141.40	7.09
Above 720 and not exceeding 1,440 square inches	Sq. foot	8c sq. ft.	55,052	105,261	4,404.16	4.18
Above 1,440 square inches	Sq. foot	11c sq. ft.	5,224	6,390	574.64	8.99
Bent, ground, obscured, frosted, sanded, enameled, beveled, etched, embossed, engraved, flashed, stained, colored, painted, ornamented, or decorated—			3,385	1,724	204.36	11.85
Not exceeding 384 square inches	Sq. foot	4c sq. ft.+4%	8,121	4,334	579.41	13.37
Above 384 and not exceeding 720 square inches	Sq. foot	5c sq. ft.+4%	5	12	.88	7.33
Above 720 and not exceeding 1,440 square inches	Sq. foot	8c sq. ft.+4%	....	799,287	77,636.33	....
Total cylinder, crown, and common window glass	.....	Dutiable				
Plate glass—						
Cast, polished—						
Unsilvered, finished or unfinished, or the same containing a wire netting—						
Not exceeding 384 square inches	Sq. foot	6c sq. ft.	262,808	167,913	15,768.48	9.39
Above 384 and not exceeding 720 square inches	Sq. foot	8c sq. ft.	442,904	363,554	35,432.32	9.75
Above 720 square inches	Sq. foot	12c sq. ft.	1,825,991	1,697,205	219,118.92	12.91
Bent, ground, obscured, frosted, sanded, enameled, beveled, etched, embossed, engraved, flashed, stained, colored, painted, ornamented, or decorated—						
Not exceeding 384 square inches	Sq. foot	6c sq. ft.+4%	7,013	4,277	591.86	13.84
Above 384 and not exceeding 720 square inches	Sq. foot	8c sq. ft.+4%	3,993	2,486	418.88	16.85
Above 720 square inches	Sq. foot	12c sq. ft.+4%	8,303	12,383	1,491.68	12.05
Silvered, and looking-glass plates, exceeding in size 144 square inches—						
Not exceeding 384 square inches	Sq. foot	7c sq. ft.	13,300	10,495	931.63	8.88
Above 384 and not exceeding 720 square inches	Sq. foot	9c sq. ft.	5,667	4,410	510.03	11.57
Above 720 square inches	Sq. foot	13c sq. ft.	16,162	12,838	2,101.66	16.37
Bent, ground, obscured, frosted, sanded, enameled, beveled, etched, embossed, engraved, flashed, stained, colored, painted, ornamented, or decorated—						
Not exceeding 384 square inches	Sq. foot	7c sq. ft.+4%	9	22	1.51	6.86
Above 384 and not exceeding 720 square inches	Sq. foot	9c sq. ft.+4%	10	30	2.10	7.00
Above 720 square inches	Sq. foot	13c sq. ft+4% ...	56	81	10.52	12.99
Fluted, rolled, ribbed, or rough, or the same containing a wire netting (excess over 100 pounds per square feet dutiable at same rates)—						
Not exceeding 384 square inches	Sq. foot	½c sq. ft.	3,375	2,435	16.88	.69
Above 384 square inches	Sq. foot	1c sq. ft.	20,658	2,941	206.58	7.02
Ground, smoothed, or otherwise obscured (excess over 100 pounds per 100 square feet dutiable at same rates)—						
Not exceeding 384 square inches	Sq. foot	6c sq. ft.	19,007	14,630	1,140.42	7.80
Above 384 and not exceeding 720 square inches	Sq. foot	8c sq. ft.	51,295	43,952	4,103.60	9.34
Above 720 square inches	Sq. foot	12c sq. ft.	284,735	194,932	34,168.20	17.53
Total plate glass	Sq. foot	Dutiable	2,965,295	2,534,584	316,014.67	....
Strips of glass, not more than 3 inches wide, ground, or polished on one or both sides to a cylindrical or prismatic form, including those used in the construction of gauges and glass slides for magic lanterns	.....	25%	....	91,793	22,948.25	....
Tiles, or tiling, opal or cylinder	.....	30%	....	33	9.90	....
Windows, stained or painted, or parts thereof, and all mirrors, not exceeding in size 144 square inches, with or without frames or cases	.....	30%	....	94,861	28,458.30	....
All other manufactures of glass or paste, etc	.....	30%	....	273,295	81,988.50	....
Total glass and glassware	.....	Free ..... / Dutiable	.... /	980,369 / 7,304,996	1,927,180.90	....

MONTHLY SUMMARY OF FOREIGN COMMERCE OF THE UNITED STATES.

Corrected to March 23, 1921.

IMPORTS OF GLASS AND GLASSWARE.

Articles	February 1920 Quantity	February 1920 Value	February 1921 Quantity	February 1921 Value	Eight months ending February 1919 Quantity	Eight months ending February 1919 Value	Eight months ending February 1920 Quantity	Eight months ending February 1920 Value	Eight months ending February 1921 Quantity	Eight months ending February 1921 Value
Glass and glassware:										
Bottles, vials, demijohns, carboys, and jars, plain, ordinarily used as containers, empty or filled ....lbs. dut.	152,357	$4,851	318,289	$18,244	1,713,871	$57,985	2,657,414	$128,827	5,997,971	264,357
Bottles, decanters, and other glassware, cut or ornamented ....dut.	.....	32,015	.....	90,784	.....	121,596	.....	325,225	.....	1,123,748
Optical instruments, including lenses and spectacles ....dut.	.....	29,674	.....	45,742	.....	108,307	.....	321,285	.....	743,643
Sheet and plate glass—										
Cylinder, crown, and common window glass, unpolished ....lbs. dut.	76,292	8,276	1,165,749	101,691	246,469	26,885	907,359	130,014	5,991,447	559,543
Plate glass, cast, polished, unsilvered, sq. ft. dut.	123,003	$4,516	223,449	193,076	273	210	141,553	95,688	2,685,146	2,425,734
Plates or disks, rough-cut or unwrought, for optical purposes ....lbs. free	79,497	103,871	131,427	87,166	499,032	237,512	422,615	357,500	737,054	714,249
All other ....dut.	.....	147,796	.....	155,847	.....	235,981	.....	595,888	.....	1,868,231
Total	.....	$410,990	.....	$692,550	.....	$788,476	.....	$1,954,436	.....	$7,699,505

EXPORTS OF GLASS AND GLASSWARE.

Glass and glassware:										
Bottles, demijohns, carboys, and jars	.....	$677,804	.....	$797,440	.....	$1,988,512	.....	$4,405,307	.....	$6,446,077
Chemical glassware	.....	19,083	.....	29,482	.....	130,821	.....	129,141	.....	221,052
Common window glass, boxes (50 sq. ft.).	46,143	$319,001	12,597	$92,190	490,717	$3,083,287	476,400	$3,054,666	329,424	$2,321,876
Exported to—										
France	.....	.....	3	25	.....	.....	4,476	35,658	7	61
Canada	12,576	80,132	977	7,020	139,055	724,501	237,574	1,317,577	141,727	918,905
Mexico	1,857	15,868	7,465	54,661	10,510	87,256	12,034	98,571	32,152	264,278
Cuba	579	4,402	1,414	11,145	24,185	167,803	16,385	113,225	30,439	235,977
Argentina	6,381	44,745	.....	.....	75,380	540,308	26,381	202,998	23,000	140,020
Brazil	5,119	35,671	6	125	24,804	163,902	35,216	259,174	17,362	120,067
Chile	3,572	20,575	.....	.....	55,817	385,293	21,377	134,020	7,878	51,323
Uruguay	.....	.....	.....	.....	.....	.....	5,615	39,563	13,556	87,616
China	4,376	34,022	3	28	.....	.....	21,942	180,778	5,135	38,429
Japan	1,280	9,931	.....	.....	2,977	39,711	13,710	122,121	10,367	84,489
Australia	1,672	11,578	200	1,360	83,283	476,463	11,808	76,699	6,821	47,647
New Zealand	569	3,540	.....	.....	20,762	108,132	3,657	23,106	944	9,100
Other countries	8,162	58,537	2,529	17,835	54,004	389,918	66,225	451,779	40,036	323,964
Cut or engraved glassware	.....	$20,659	.....	$20,642	.....	$109,453	.....	$198,044	.....	$277,267
Plate glass, unsilvered .....sq. ft.	342,944	222,881	368,071	283,820	5,560,322	3,106,660	3,089,971	1,773,953	2,452,698	1,874,888
All other	.....	837,900	.....	1,113,560	.....	4,209,576	.....	5,956,003	.....	9,734,499
Total glass, etc.	.....	$2,097,328	.....	$2,337,143	.....	$12,688,309	.....	$15,517,114	.....	$20,875,659

Current Prices of Glass-Making Materials

From quotations furnished by various manufacturers and dealers
New York, May 8, 1921

	Carlots.	Less Carlots.
Alumina hydrate .....lb.		.12 - .14
Arsenic trioxide (dense white, 99 per cent.....lb.	.08	.08½
Barium carbonate.....ton	$65.00	$75.00
Bone ash .....lb.	.05	.05½
Borax .....lb.	.06¼- .07½	.07 - .07½
Borax, fused, any mesh....lb.	.19	.20
Boric acid, fused.....lb.	.35	.35
Cadmium sulphide, red or orange .....lb.		1.60
Cadmium sulphide, yellow..lb.		1.60
Cobalt oxide.....bbls., lb.		3.00
Cobalt oxide,..... tins, lb.		3.10 -3.25
Copper oxide, red.....lb.		.17 - .20
Copper oxide, black.....lb.		.23 - .26
Feldspar, 100 mesh.....ton	18.00	
Fluorspar, powdered white 90 per cent.....ton	55.00	60.00
Kaolin .....ton	25.00	35.00
Kryolite .....lb.		.15
Lead oxide, (red lead, Pb_3O_4) .....lb.	.08¾	.09
Litharge (PbO) .....lb.	.08¼	.08½
Lime—		
Hydrated .....ton	45.00	
Burnt .....ton	17.00	
Manganese (85% MnO_2)...lb.	.04¼- .06	.04½- .06½
Nickelic oxide(NiO) black—lb.		.35
Nickelous oxide (Ni_2O), green .....lb.		.38
Potassium Carbonate—		
Calcined .....lb.		.07 - .07½
Hydrated .....lb.		.12 - .14

Current Prices—(Continued)

	Carlots.	Less Carlots.
Potassium nitrate.....lb.	.09¾	.10
Powdered blue.....lb.		.30
Salt cake, for glassmakers..ton	25.00	
Selenium .....lb.		2.25
Soda Ash, 58% dense (48% basis), bulk .....100 lb.	1.70	1.80
bulk, on contract.....100 lb.	1.65	
Sodium nitrate .....lb.	.06	.07
Sodium selenite.....lb.		2.25
Sulphur (flowers) .....lb.	.03¼	.03½
Uranium oxide .....lb.		2.25
Zinc oxide (ZnO).....lb.	.08½	.09

Stock Quotations

(Reported by Moore, Leonard & Lynch, Frick Building, Pittsburgh, Pa.)

Pittsburgh Stock Exchange—May 6.

	Bid	Offer	Last
Am. Window Glass Mach, Com.....	60	62	61¼
Am. Window Glass Mach. Pfd.....	..	..	74¾
Am. Window Glass Pfd.....	..	97	93
Pittsburgh Plate Glass	..	116¼	116
U. S. Glass	..	40	40

Market dull and weak.

Wheeling Stock Exchange—May 6.

Fostoria Glass Co.	..	108	108
Hazel Atlas Glass Co.....	135	143	140
Imperial Glass Co.	..	120	120
Central Glass Co.	..	160	160

Toledo Stock Exchange—May 6.

Libbey-Owens Sheet Glass Co. Com....	100	110	104½
Libbey-Owens Sheet Glass Co. Pfd....	98	102	..
Owens Bottle Machine Com.....	47½	50	48
Owens Bottle Machine Pfd.....	..	100	96